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The Stations of the Washington St. Tunnel, Boston, Mass.

By LAURENCE B. MANLEY.*

The Washington St. tunnel, which was opened for public use on Nov. 30, 1908, after four years of construction, is 6,110 ft. in length including both inclines to the surface, and cost, excluding land damages, a little over five and one half million dollars. As a part of the work, the Haymarket Square station of the subway has since been enlarged and connected with the Washington St. tunnel by a large sub-passageway which was thrown open for transfer purposes on May 23, 1909.

The tunnel is for two tracks and runs for the greater portion of its length under Washington St. through the heart of the city. It was built by the Boston Transit Commission, acting for the City of Boston, under Chapter 534 of the Acts of 1902, of the Massachusetts legislature, with the object of relieving the congestion in the Tremont St. subway by providing separate accommodations for elevated trains ordered removed from the subway by the act. It is leased for twenty years to the Boston Elevated Ry. Co., at an annual rental of 4½% of the cost and forms the main distributing artery of the company's elevated system, serving about a quarter of a million passengers daily.

The main structure has been described elsewhere,† the purpose of this article is to give a description of the tunnel stations and their appurtenances, including some details of the work of transforming the concrete structure, as left by the construction contractors, into the finished tunnel equipped for use.

ESSEX STATION LOOKING NORTH, WASHINGTON ST. TUNNEL, BOSTON.

General Description.

The Washington St. tunnel has eight station platforms, four on each track. The interiors of these absolutely fireproof stations, besides being admirably adapted for the rapid and safe handling of large crowds of people, are impressive on account of their length and size, their substantial and massive appearance (due partly to the cement-encased steel members) and the clean, white simplicity of their walls and ceilings. The platforms are each 350 ft. long, to accommodate eight-car trains, and occupy the length of a city block. They have a width of from 11½ to 26½ ft., depending on the width of Washington St. and, including lobbies for ticket offices, have an average area at the track level of 9,000 sq. ft. The platforms are as nearly level and straight as Boston conditions will permit, but curves of long radius and grades up to ½% (the limiting condition under which a train will stand without having the brakes set) have necessarily been introduced on a portion of their length.

Sub-passageways beneath the tracks have been provided between the north and south bound platforms at Boylston and Essex stations and at Winter and Summer stations, but are not at present used by the public. The Milk and State platforms are connected by a long passageway known as the "speedway" carried over the north bound track, enabling passengers going south to transfer from the East Boston tunnel at Devonshire St. to Milk station. The large sub-passageway, lately completed, at Haymarket Sq. permits transferring between the subway and the tunnel at that point.

Twenty-two stairways, all of which, except that at Adams Sq., reach the street through what was formerly private property, render the station platforms accessible from at least two places, generally through lobbies at the ends of the platforms. The Union and Friend platforms, the only opposite platforms in the tunnel, are reached through a single lobby placed over the track. The lobbies contain the ticket offices, parcel and toilet rooms, fences by means of which the incoming and outgoing passengers are separated, etc. The ticket offices are so arranged, nearly at right angles to the path of the incoming passenger, that he may buy his ticket and pass by the choppers without having his path crossed at any time by purchasers of tickets from other offices. No turnstiles are required on the exit passageways, the man at the choppers being so situated as to control them from his post. In the place of turnstiles, gates have been installed, but, except at the Union-Friend lobby, it has seldom been found necessary to close them between trains.

The in and out stairways are in general of two types. The first type, at La Grange St., Temple Place, Franklin St. and Union-Friend station, consists of a single 15-ft. stairway, divided by a middle handrail into in and out passageways. The second type consists of separate stairways respectively affording an entrance to the station from Washington St. and an exit onto a side street. At Essex St. and at Summer St. additional passageways have been provided for entering from the side street. The arrangement at Summer St. is shown by Fig. 2. The maximum climb to the street is at State station, where the Washington St. tunnel passes beneath the East Boston tunnel. Here the edge of the platform is 30.45 ft. below State St. at the head of the stairs. The average climb at the other stations is about 19 ft. To relieve the situation at State station, four electrically-operated Reno inclined elevators, two going up and two going down at the rate of 100 ft. per min., have been installed, which convey the passengers between the platform and the lobbies under State St., a vertical distance of about 20 ft. The maximum capacity of one single-file elevator during the official test was at the rate of 3,800 passengers per hour. The outside faces of these elevators are inclosed between tiled concrete walls and the inside exposed faces are covered with sheet brass, the only inflammable parts showing being the wooden hand-rails and the moving treads.

Carborundum-filled safety treads 7 ins. wide are set in the concrete stairs, which generally have risers 7 in. high and treads, including the 1 in. overhang, 12 ins. wide. The handrails are of oak.

The coverings over the stairs leading to the sidewalk at Adams Sq. and to the passageway by the side of the Old South Meeting House are of unique design, the end sought being to se-

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†Engineering News, April 19, 1906, p. 438; Feb. 14 1907, p. 181.

cure a light and fireproof structure which should obstruct the view from surrounding buildings as little as possible. Fig. 4 shows a typical covering of this kind at Adams Sq. It is constructed of reinforced concrete, with a curved, sloping roof, in which glass sidewalk lights have been set for illumination. The work was done by the Aberthaw Construction Co. of Boston.

The remaining tunnel entrances are situated in existing buildings, takings of a part or the whole of the property occupied having been made for the purpose. The stairway walls and coverings are constructed of concrete and steel not only ample to protect the tunnel should the surrounding property be destroyed by fire, but also of sufficient strength, in many instances, to support the highest building permissible under the building laws. The street fronts of these entrances have been given conventional architectural treatment harmonizing with the surrounding property, the structural steel framework being covered by cast iron fascia or by concrete casings. At eight of the entrances panelled casings of hammered concrete made of white and black marble chips and cement, and called on account of its appearance granite composite, were constructed by Emerson & Norris of Boston. At the Boylston St. entrance and exit the composite was molded at the shop in sections 3 ins. thick and set in place, the joints being cunningly hidden. Where used elsewhere the composite was cast in place from plaster of paris forms, which were first molded in position from wooden positive forms brought from the shop. The surface, which has recessed panels with sharp straight arrises, was given a fine bush-hammered finish and is a beautiful piece of workmanship.

Bronze illuminated lanterns overhanging the sidewalk serve to locate the entrances. Directory panels of Blanco marble at the street level give the destination of trains. A heavy ornamental steel grille, painted copper brown, is placed over many entrances and acts as an accessory to the Bostwick folding gates by which the tunnel is closed during a part of each night.

Ventilation.

Ventilation of the tunnel is secured by means of four pairs of fans of a nominal capacity of 25,000 cu. ft. of air per min. These exhaust the vitiated air from points between stations and convey it to the surface through concrete ducts, either above or below the tracks. The air is discharged through special gratings above the street level, the only sidewalk grating being by the side of the monument in Adams Sq. a place little traversed by pedestrians. At La Grange St. the vitiated air is discharged through a concrete chimney, 40 ft. high, in the rear of the station. Fresh air is admitted at the portals and at the station entrances.

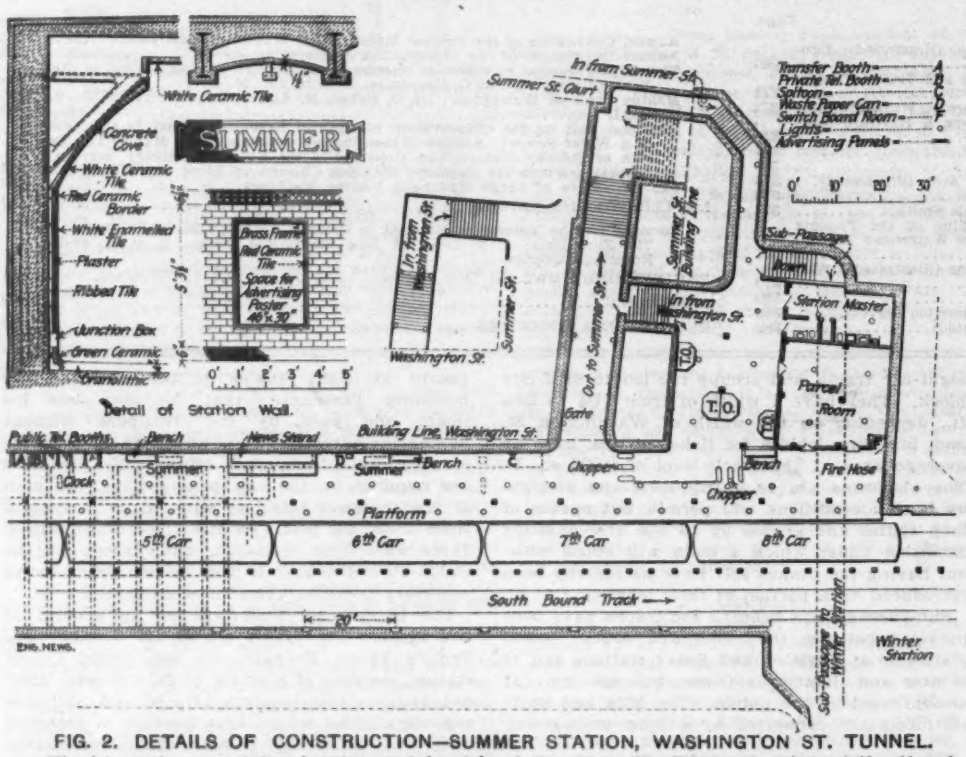


FIG. 2. DETAILS OF CONSTRUCTION—SUMMER STATION, WASHINGTON ST. TUNNEL.

(The false arches are reinforced with expanded metal and the coves with Clinton wire cloth of No. 10 and No. 8 wires, respectively, spaced 4 ins. vertically and 8 ins. horizontally. The drain at the back of the ribbed tile connects with cross platform drains between each column which extend to the track under the overhanging nose of the platforms. Drains in each column, to care for ceiling leaks, also connect with the platform drains.)

Lighting.

The tunnel is lighted entirely by 16-c.-p. incandescent lights, as shown by the illustration. The wiring and conduits are concealed in the tile.

The lights in each station are controlled from fireproof switchboard rooms at each end of the platform, each board controlling one-half of the circuits at that station. In the switchboard at one end of the platform is an automatic switch connecting with the emergency trolley wire in case of accident to the main cables. In the switchboard at the other end of the station is a manually-operated switch connecting with the Edison current, which is transformed and distributed from the main switch room at State station. Both rooms have provision for disconnecting the third rail in front of the station platform.

Decoration and Equipment.

The stations, in addition to the accessories already mentioned, are equipped with numerous booths and other appliances for the convenience of the public as well as to facilitate the operation of the tunnel. This equipment has been especially designed and is fireproof throughout. Its installation has been a matter of co-operation between the lessee of the tunnel, the Boston Elevated Ry. Co., and the Transit Commission, the company in general furnishing the tracks, lighting, ticket offices and other operating equipment, while the Commission has installed the permanent partitions, elevators and such fences as are necessary for the safety and convenience of the public.

In connection with the design of the operating equipment, the Railway Co., through its consulting board of architects, has submitted plans for a somewhat more ornamental treatment of the station walls than was originally proposed. These were with few exceptions adopted by the Transit Commission. The plans were made under the direction of Mr. Robert H. Peabody, of the firm of Peabody & Stearns. In accordance with the adopted design the station walls, the ceilings over the entrance stairways and, except at Milk and State stations, the ceilings over the main platforms have been covered with white tile relieved by a narrow colored tiled border on the walls at the height of the eye and by colored name panels and borders around signs and door openings. The untiled ceilings and walls beyond the tracks are generally of plaster finished white either by the use of white Portland cement or Koat-o-Stone, the original surfaces with few exceptions not being considered sufficiently smooth for finished work when compared with the tiled surfaces adjacent. The encased platform columns are also white from the roof down to the level of the border on the walls, the remainder of the columns being painted the station color and varnished for the sake of cleanli-

FIG. 3. MAIN PLATFORM AT WINTER STATION LOOKING SOUTH, WASHINGTON ST. TUNNEL.

(The uncompleted news-stand is in the foreground. In the middle distance by the clock are five telephone booths and one booth for transfers. The tiling is similar to that shown in detail on Fig. 2 the name panels being set opposite the middle of each car. Note the rounded corners and absence of dust-collecting ledges. The lighting is from 16 c. p. incandescent lamps placed at the crown of alternate arches over the middle and edge of the platform.)

ness. The color of this paint and the tiling is distinctive for each station, and changes at each platform on the same track. The stations most nearly opposite on different tracks have the same prevailing color, so as to give an observer in the cars a general idea of his whereabouts at a glance. The colors used are gray at Boylston and Essex stations, terra cotta at Winter and Summer stations, dark green at Milk and State stations and blue at the Union-Friend station.

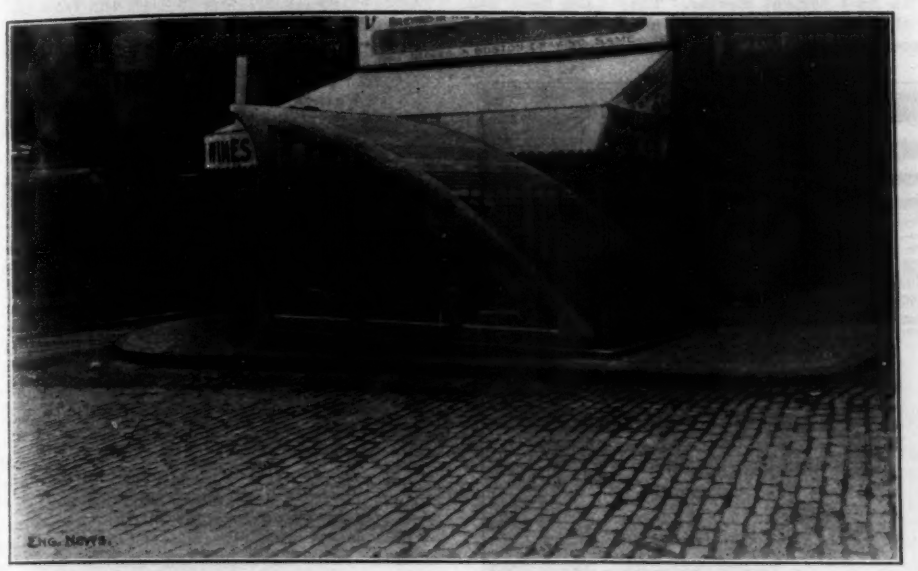


FIG. 4. REINFORCED-CONCRETE STAIRWAY SHELTER AT ADAMS SQUARE, WASHINGTON ST. TUNNEL.

(The roof slab is 1¾ ins. thick built on a curve of 25 ft. radius and is reinforced by 3/16-in. twisted rods laid each way between the glass sidewalk lights. It is further supported by six reinforced-concrete cross beams at, and between each pilaster. The glasses are 2¾ ins. in diameter and spaced 3½ ins. on centers. The entire structure, except the light panels in the sides, was molded in one operation.)

Special precautions have been taken throughout the work to produce smooth walls and to eliminate all ledges which might collect the oil and iron-laden dust so prevalent in the vicinity of the third-rail. For this reason and in order to conceal the electric lighting conduits, thin concrete arches sprung between the encased flanges of the roof beams, and cove walls of concrete covering the kneebraces have been built at many of the stations and subsequently tiled or plastered. The general method of their construction is shown on Fig. 2. Similar arches having a veneer ⅜-in. thick of white Portland cement mortar below the reinforcement were molded in sections, on smooth forms on the platform, and placed in position over the tracks of the four southerly stations without further treatment than smoothing the edges and washing with white cement. The cost of making and setting these white slabs in place was about 16 cts. per sq. ft., as against 22 cts. per sq. ft. for arches molded in position.

The arrangement at Summer station (Fig. 2) of the telephone and transfer booths, news stands, station master's room, parcel room, switchboard room, and toilet rooms for the use of employees only, is fairly typical of the remaining stations. Fig. 2 also shows the location of the copper covered ticket offices and choppers, the copper sputum and waste paper cans and the reinforced-concrete seats which have been provided at intervals along the walls.

The partitions forming the booths and rooms above mentioned are of 4-in. hollow terra cotta partition blocks strengthened by reinforced-concrete frames around window and door openings and are tiled and plastered to correspond with the remainder of the tunnel walls. Fig. 6 shows in detail this method of construction around a door opening. The cost of these partitions was about $6.80 per sq. yd., when covered with tile on one side and plastered on the other.

The doors and windows are of white pine, with asbestos-board or plate-glass panels, and are covered on both sides with 16-gage sheet bronze. In each parcel room are one or two dutch doors, the lower leaf having a shelf for checking bundles in addition to the regular checking windows. The telephone doors are hollow and double glazed, with an intervening air space. The cost of these doors installed complete with hardware runs between $110 each for dutch doors (3 ft. × 6 ft. 8 ins.) having a transom overhead, to $56.75 for switchboard and closet doors (2 ft. 6 ins. × 6 ft. 6 ins.) with a panel of plate glass. The doors were furnished and installed by John W. Rapp of New York.

The floors are of concrete, troweled smooth except at the division next the tracks, which was given a rough floated surface to prevent slipping. A 6-in. wide border of white cement gives the edge of the platform a finished appearance and serves to warn the absent-minded of the unprotected edge 3½ ft. above the tracks. In the lobbies the floors have grades as steep as 6% to avoid extra stairs and the passageway from State station to Adams Sq., with a grade of 8%, has cross marking every 6 ins. to prevent slipping. The main loading and unloading platforms, however, have no grades greater than the 2% pitch for drainage from the walls to the tracks. The finish concrete on the platforms and many of the concrete stairs were constructed by Coleman Bros., of Boston.

Solid concrete fences have been erected by the Commission on some stairways and passageways to prevent spitting through. That at the sides of the "speedway" at State station is 8 ft. 2 ins. high with a heavy coping and base with ornamental vertically fluted panels of a minimum thickness of 2 ins.

The concrete fence between the columns separating the north and south bound tracks at Boylston station is 3 ins. thick with a plain rubbed surface on both sides free from marks of forms. It is reinforced with ½-in. rods drilled into columns and spaced 12 ins. on centers. It cost, including the contractor's 15% on the labor, 30 cts. per sq. ft.

All of the finish concrete on the inside of the tunnel has been given a smooth rubbed surface for ease in cleaning. This surface was obtained by removing the forms while the concrete was yet fresh, smoothing the irregularities due to the forms, and rubbing in with a board or a float a grout of sand and cement mixed one to one so as to completely fill the pores. By a careful selection of materials several colors have been obtained. For example, stair copings and fences much rubbed against have been darkened by the addition of lampblack to the grout, white Portland cement rubbed into the fresh concrete has given excellent white surfaces to trusses beyond reach. The use of screened stone dust in place of sand has given pleasing light gray surfaces.

Much of the finish concrete work, including the casing of steel, has been done by picked gangs under competent foremen from the various tunnel contractors at cost plus 15% on the labor, the materials being bought directly by the Commission. As the contractors furnished the hand tools and paid about 9% of the payroll for insurance out of this 15% their profits were only moderate.

Cement Plastering.

It has been the practice in the plastering work under review to wet the walls previous to plastering and to keep the plaster damp for three days. A grout of cement applied to the concrete a few hours before plastering has apparently been of material service in strengthening the bond. The plaster has been mixed in the proportion of one part of cement to two parts of sand by volume and has been applied in one, two or three coats according to circumstances. In order that the finished plaster should present a smooth surface and a uniform color it was found necessary that the last coat should be of a nearly constant thickness and trowelled as little as practicable. For walls beyond the tracks where it was sufficient to follow the general surface of the concrete, one preliminary scratch coat was sufficient to fill out the irregularities of the surface, but where perfectly plain work was required it was often necessary to put on an intermediate or "browning" coat over the scratch coat, sometimes in two or three layers over deep hollows, before applying the finish coat. No trouble was experienced in the bond between coats, but it was found absolutely necessary that the under coat should become well set before putting on another. A failure to observe this requirement in an attempt to hurry the work was the cause, in one instance, of a considerable amount of plaster coming off.

Many of the ceilings which were not tiled have been plastered with white Portland cement, with very pleasing results. It was found that sand of only moderately light color is necessary for this work, as the white cement, if the mortar is properly mixed, completely covered the grains of sand, giving a good white appearance to the whole surface. The last thin coat only has been of white cement mortar, so that the cost of such work is only slightly in excess of plastering with the ordinary gray finish. It is not easy to produce a smooth troweled surface with the brands of white cement used on the Washington St. Tunnel, and on that account many of the ceilings so plastered have been given a rough floated finish. A smooth troweled surface has, however, been required on the walls for all plaster.

Several contracts for plastering with white cement to a plane surface have been let for 75 and 76 cts. per sq. yd., the white cement being furnished by the Transit Commission at the same price as the gray, but the contractors made little or no money on the work and did not want more of it at the same price. On one piece of three-coat ceiling plastering with white cement the actual cost was 80 cts. per sq. yd. A large amount of two-coat plastering with gray cement, following the surface of the concrete,

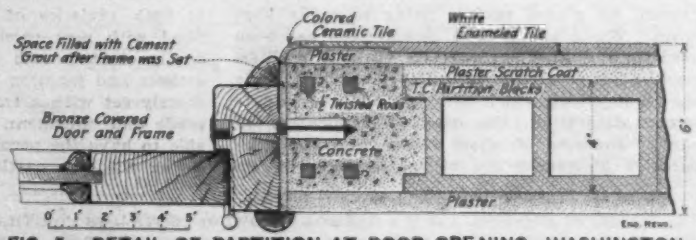


FIG. 5. DETAIL OF PARTITION AT DOOR OPENING, WASHINGTON ST. TUNNEL, BOSTON.

has been done at 60 cts. per sq. yd., and several walls have been plastered to a true plane surface with three coats of gray cement at prices varying from 75 cts. to $1.00 per sq. yd. In all these cases the cement was furnished to the contractor at $1.75 per bbl.

Tiling.

The most important item of the finish of the Washington St. tunnel, both in time and in money expended, has been the tile work. About

FIG. 6. MILK STATION LOOKING SOUTH, WASHINGTON ST. TUNNEL.

(The platform is over the north-bound track. The walls beyond the track, ceiling and tierods are not tiled but the cement surface is whitened with Koat-o-Stone. The tierods and columns are covered with cement mortar in accordance with the practice of encasing all structural steel to prevent rusting. Beyond the clock, a suspended ceiling of concrete 4 ins. thick forms the bottom of the ventilating duct.)

15,600 sq. yds. of tile, or over 22½ million separate pieces, have been set at a cost, including the ribbed tile backing and other incidental work, of $110,000. The main work was done in six contracts and occupied a little over a year, the length of time to complete the work being largely due to many details and to numerous tiled partitions being suggested and added as the work progressed.

Most of the tile was laid on a backing of half-ribbed terra cotta furring 1¾ and 2 ins. thick, put on the walls to afford drainage and to prevent condensation on the surface. The furring also served to conceal the electric lighting conduits. It was laid with 1:1 Portland cement mortar and plastered with 1:3 mortar to a plane parallel with the finished tile surface, allowing ¾-in. for the thickness of the enameled tile, and ⅝-in. for the ceramic. The furring was omitted on the ceilings and some walls where there was no possibility of leakage.

For the walls between the base and the border, where the tiling is most frequently rubbed against by passers by, white enameled tile was chosen, its glazed surface being so easily kept clean. White and colored ceramic tile has been used for the other surfaces, its vitreous qualities rendering it proof against ordinary accident, while the facility with which it can be adapted to patterned decoration, the ease of application to curved surfaces of short radius and its comparative cheapness are other elements in its favor. Its main disadvantage has proved to be the readiness with which dirt sticks to its surface when not regularly cleaned.

The enameled tiles used have been 6 × 3 × ⅝-in. in size set on a floated mortar surface mixed in the proportion of one part cement, two parts sand and one-quarter part lime putty and skimmed with neat cement mortar. They have been laid with broken joints with the long edge horizontal, except around curves of short radius, where of necessity the long edge was set vertically. A curved surface of 18-in. radius has proved to be the limiting condition of this arrangement, and it is even then practicable only by beveling the inside edges of the tile. The enameled tile used on the Winter and Summer stations was imported from England, the remainder of the tile used being of various American makes. The English tile was harder and consequently more warped than the American tile, but so far appears somewhat more immune from crazing than that made in this country.

The ceramic tiles are ⅝-in. square and ¼-in. thick, and come from the manufacturers pasted on their faces to sheets of manila paper 12 × 24 ins. These sheets of tile were handled somewhat like wall paper and were set on the same bed as that described for enameled tile, except that the neat cement mortar was spread on the back of the tile before setting in place. The paper support was soaked with water and removed as soon as the tile set in place, and irregularities in the courses and in the plane of the surface were at once corrected. The joints in both varieties of tile were then completely filled with neat cement and the whole surface finally cleaned with muriatic acid. The lamp sockets and junction boxes which had been previously set with a transit served as a guide for grade and alinement. It was found very desirable to have the permanent lights in place while laying the tile, particularly the ceramic, as a slight variation from the true surface which casts an ugly shadow under the permanent lighting is often unnoticeable where viewed by temporary illumination in front of the work.

An eight-hour day's work for a tile setter and helper on straight work has been from 200 to 250 sq. ft. for setting ribbed tile, not including plastering, 80 sq. ft. for ceramic tile and from 60 to 70 sq. ft. for the enameled tile.

The accompanying table gives the contractors for tile work and the contract price.

Paints and Cement Coatings.

It having been decided to whiten the untiled concrete surfaces of the stations, a number of white paints and cement coatings were experimented with to determine their fitness for use in the tunnel. While no one of the numerous samples proved entirely satisfactory the three coverings which were most favorably regarded and which were used were Wadsworth, Howland & Co.'s Bay State Cement Coating, Koat-o-Stone, a patented preparation manufactured by the Koat-o-Stone Co., of New York, and white Portland cement.

The Bay State Cement Coating is well known, and has been considerably used in the subway and the East Boston tunnel. It is applied as a paint, generally requiring two coats, and adheres well to the concrete surface where not too damp. Its color is a flat creamy white. It has been used principally on the station columns.

The Koat-o-Stone gives a white, almost glazed, surface, very handsome on smooth plastered work and easy to keep clean. It is nearly as hard as the cement which it covers, and after it is set will stand water running over its surface without being damaged, but will not preserve its integrity for any considerable length of time on a wall through which water is seeping. Its chemical composition is kept secret by the makers, but it appears, on analysis, to have the properties of Portland cement with about 25% zinc added for whiteness. It is applied in one or two coats with a final coat of strong colorless alkaline liquid which sets the coating. Before the setting solution is put on the Koat-o-Stone acts like a cold water paint and can be washed off with water. For this reason it is necessary that the walls on which it is applied should be free from running water, although in its application the wall is first dampened as would be the case in applying cement wash. Its chief defect has been a tendency to peel from surfaces where conditions such as a previous coat of paint or cement wash or oil or grease on the surface have prevented a sufficient amount of absorption of the coating into the concrete. Where conditions for absorption have been favorable the Koat-o-Stone has adhered to the concrete with great tenacity. Koat-o-Stone has been used to cover the gray plastered sidewalls and ceilings above the tile, the most notable instance being on the walls and ceiling of the milk station.

The white cement has been put on generally in the form of plaster, it being found cheaper to plaster the walls with white cement than to use ordinary gray cement plaster and afterwards whiten it. White cement is improved rather than hurt by dampness, an extremely important factor in tunnel work. Its greatest defect has been the roughness of its floated surface, which in time becomes dirty under the conditions prevailing in the tunnel. White cement has been used on the untiled ceilings of the station lob-

TABLE I.—SHOWING CONTRACTS FOR TILE WORK; WASHINGTON ST. TUNNEL, BOSTON.

Contract.	Contract No.	Contractor.	Half-ribbed terra cotta tile backing on vertical walls, per sq. yd.	Half-ribbed terra cotta tile backing where temporary support is required, per sq. yd.	Plastering not exceeding ¾-in. in thickness, per sq. yd.	Plastering ¾-in. to 1¼-in. in thickness, per sq. yd.	White enameled tiling, per sq. yd.	Ceramic mosaic tiling (walls and coves), per sq. yd.	Ceramic mosaic tiling (ceilings), per sq. yd.	Ceramic angle pieces (per lin. ft. in addition to price per sq. yd. for enameled and ceramic mosaic tiles).	Ceramic mosaic tiling (borders and name-signs), per sq. yd.	Ceramic mosaic tiling (sanitary base), per sq. yd.	Ceramic mosaic tiling (forming recesses for advertising panels), per sq. yd.
Boylston and Essex stations	325	William H. Smith	$0.54	.....	.....	.....	$4.73	$4.73	$5.58	$0.20	.....	$8.10	.....
Summer and Winter stations	324	Murdock-Shaw Co.	.....	.....	.....	.....	.....	4.63	5.70	.....	.....	.....	.....
Summer and Winter stations	323	Boston Tile & Mantel Co.	.58	.....	.....	.....	4.60	.....	.....	.....	.....	5.71	.....
Milk station	339	The C. M. Tyler Co.	.61	$1.55	$0.73	$1.30	5.49	4.71	6.07	.19	$0.25	8.47	$2.00
State station	338	William H. Smith	.63	1.50	.72	1.22	5.53	4.70	5.90	.22½	10.00	9.50	3.00
Union-Friend station	340	Murdock-Shaw Co.	.63	1.75	.70	1.26	5.57	4.65	5.93	.21	9.50	9.10	3.37

TABLE II.—SHOWING PRINCIPAL CONCRETE AND PLASTER MIXTURES USED ON THE WASHINGTON ST. TUNNEL, BOSTON.

Cement, 380 lbs. or 4 bags.	Sand, cu. ft.	Fine crushed stone, cu. ft.	Crushed stone, ¼ to ½-in., cu. ft.	Crushed stone, ½ to 1-in., cu. ft.	Crushed stone, 1 to 2-in., cu. ft.
Structural concrete Sections 1, 2, 3, 4, 5	5	5	..	..	17
Structural concrete Sections 6, 7, 8, 9	5	5	..	..	14
Concrete for thin reinforced walls and stairs	3½	3½	5	5	..
Base for concrete walks	3½	3½	4	10	..
Granolithic wearing surface	3½	3½	(Newburyport)		
One covering over stairway Sec. 5 (suspended ceilings)	5	5			
Remaining coverings over stairways, Adams Sq. and Sec. 5 (ornamental fences, tie rods, casing, etc.)	2½	2½			
Thin concrete arches and coves (plain fences)	6	6			
Column casings, Sections 1, 2, 3, 4	4	4			
Column casings, Section 6	2½	2½			
Column casings, Section 9	5	5			
Finish plaster	1½	Same for grey and for white cement.			
White granolithic edge of platform (white Port. cement)	4	Crushed quarts.			
White veneer on thin arches untiled (white Port. cement)	4	Beach sand.			
"Granite composite"	8½	Cu. ft. white and black marble chips.			

bles at Boylston, Essex, Winter, Summer, Franklin and State Sts. and at Temple Place.

The work of the Transit Commission was done under the direction of its Chief Engineer, Mr. Howard A. Carson, M. Am. Soc. C. E. Much of the finish concrete work, including the ventilating ducts, the encasement of some of the steel and the construction of the concrete shelters over stairways, was done under the immediate charge of Assistant Engineer G. D. Emerson. The tilework, plastering, painting and much miscellaneous work was under the charge of the writer.

The work of the Boston Elevated Railway Co., except that done by its consulting board of architects before mentioned, was done by its regular staff.

A Public School for Teaching the Rudiments of Mechanics and Textile Trades.*

By W. H. DOOLEY.†

Almost all the textile and many of the technical schools of the country provide a training for students over 16 years old who have the equivalent of a high-school education. The same courses are provided evenings for those working in mills during the daytime. This education, being the highest possible training in the textile arts, often exceeds the needs of the ordinary mill positions and little effort is made to supply a simpler training to those of the great mass of operators, between 14 and 17 years old, who desire a useful education.

Since the technical schools of college grade were established a great change has taken place in the industrial world. Specialization has become the keynote. The apprenticeship system, in the textile industry particularly, has declined and disappeared. A boy or girl that applies now at a mill for a position is placed at some machine or in some part of the mill and is kept there to perform the same operation day after day until it becomes a habit and he or she loses the full power of initiative and the habit of reasoning, developed in earlier school days.

Herein lies the need of schools to provide systematic training, in our mill centers, for boys and girls of 14 to 17 years of age and which will show them, for instance, the broader principles and simple operations of the textile industries; which will supply the information and give the training not allowed by the present organization of that industry, perhaps more than by others. Such schools would parallel our existing high schools providing what has been called "secondary education" during the daytime, and at night what would be adjusted to meet the daily needs of the operatives and mechanics.

For several years I have been deeply impressed with the need of secondary technical education in textile manufacturing, and two years ago, while instructor in the Lawrence High School, I resolved to find an opportunity to put my ideas into effect. I found, not only that Lawrence needed such a school, but that it could be started, with but slight expense, by occupying some unused buildings belonging to the city, and using, as a nucleus, a small school conducted by the loom-fixers' union. As a result a school for the sort of education outlined has been in existence in Lawrence for the past two years.

Prominent business men believed in the scheme, but were afraid that the city could not stand the expense of equipping such an institution. The trade unions were opposed to the school because they believed it was a scheme to flood the market with help and break the unions. It was difficult to arouse public sentiment. In order to overcome all opposition the school was started in the loom-fixers' union hall as an evening school for those already engaged in the trades. Classes were formed in loomfixing and calculations, mill arithmetic, textile designing and cloth calculations. The writer gave his services free as an instructor in mill arithmetic, and in order to make the work practical, placed question boxes around the school-rooms, so the problems and questions would come from the operatives. The school was a great success from the beginning and the attendance increased to such an extent that it became necessary to provide new quarters.

The school was then taken over by the city and established under the Industrial-School Act allowing "cities and towns to establish industrial schools under boards of trustees" the state reimbursing the city to the extent of one-half of the cost of maintenance. By the provisions of the law, the school has three distinct functions: (1) that of offering to children who have reached the age limit of compulsory education a further preparation for some form of industrial occupation; (2) to offer to those already at work an opportunity for further study to aid them in becoming more efficient workers, and in advancing in their occupation; (3) if deemed expedient, to offer to young men already employed, part time instruction in which the employer gives the time out of the working-day. This school, so far, is meeting the first two provisions of the law, leaving the question of part time work until some specific request should come from some manufacturer. It naturally divides into two general departments, that of day work dealing with persons over 14 years old, but who are not employed, and that of the evening work dealing with persons already employed.

The scope and character of the work is best shown by giving a brief outline of the courses of study. Mental as well as mechanical education is provided but the fact is always kept prominent that graduates must meet the demands of the textile and mechanical industries of this city. Yet it does not propose to turn out graduates capable of doing journeymen's work in any trade, so that it differs from a trade school.

Mechanic Arts.—First Year: English, arithmetic and bookkeeping, industrial history, mechanics and electricity, study of wood and iron and the process of working blue-print reading and machine sketching.

Second year: English, shop mathematics and bookkeeping, industrial history, mechanics and electricity, drafting and sketching, study of the processes for iron.

Third Year: English, shop mathematics, industrial history, drafting, machine-shop practice.

Textile Arts.—First Year: English, arithmetic and bookkeeping, industrial history, mechanics and electricity, raw material, carding and spinning, weaving and warp preparation, designing.

Second Year: English, mathematics and bookkeeping, industrial chemistry, industrial history, carding and spinning, weaving and warp preparation, fabric analysis and designing.

Third Year: English, mathematics and bookkeeping, industrial chemistry, industrial history, carding and spinning, weaving and warp preparation, fabric analysis, designing, dyeing and finishing.

There is in addition a course in domestic arts, for girls, including the study of English, arithmetic, history, dressmaking, millinery and cooking.

The work of each year is complete in itself so far as it goes. Nothing is taught on the idea that it will be useful later in the course. In the first year the simple and fundamental parts of each branch are given. In the second year the same work is pushed a little further and in the third year it goes as far as possible. Whenever a pupil leaves the school he will have had, up to that time, the best preparation the school can give and he can study the same branches further in the evening courses.

This brings us to a consideration of the second department—that of the evening sessions. There is no question but that the most ambitious workers in any industry will take advantage of every advantage of evening study. The success of the correspondence courses of the Y. M. C. A. classes and of the textile schools show that. In the city of Lawrence, before this industrial school was opened, over 140 workers traveled 18 miles to attend evening sessions in Lowell, going directly from the mill and deferring their evening meal until they reached home at midnight. Over 2,000 workers are enrolled in correspondence courses but, as such instruction is difficult and rather unsuccessful, the men are soon discouraged and lose faith.

The regular evening schools have not met the needs of the workers. What is needed is a school with lower entrance requirements and giving simple instruction of a character more directly vocational and concerned with the daily needs of the local industries. Our problems, drawings and notes are from the shops and mills. Problems are obtained from question boxes placed in the mills and in the school-rooms. Special text-books are used, edited by the instructors who are practical workingmen in the industries. The students are classified into vocational classes according to their trades. For example there is a class in arithmetic for engineers and a class in the same for boiler firemen. Again, the textile designers have a class in arithmetic called cloth calculations. This idea carries out the plan of the old trade guilds, where the daily trade experiences of each member become the property of all members. Our evening students are grouped according to their occupations, and in this way have an opportunity to talk over these interests. The teacher acts as a leader and draws out the students in telling their trade experiences, and through the expression of these various opinions the practical solution of the particular problem at hand is obtained. It is difficult to get these students to recite and express themselves at the black-board. A free discussion of the point at issue makes such a student lose his self-consciousness, and soon he is at the board illustrating his solution. Such discussions are under the direction of the teacher.

Provisions are made for students who cannot attend but once or twice a week. In prosperous times the mills run evenings, and the employed are expected to work overtime. But they can usually get away for one night in the week during such times, though they cannot tell definitely what nights they will be called upon to work. Students who are thus working overtime are allowed to attend any night during the week after the work is fairly started. Such a plan has been found really feasible. In a word, every effort is made on the part of the instructors to accommodate the changing time schedule of the individual student, and to awaken within him that self-interest in the progress of his school work, which will enable him to do the very best of which he is capable.

*Abstract of a paper presented before the National Association of Cotton Manufacturers, Bretton Woods, N. H., Sept. 22.

†Principal Lawrence Industrial School, Lawrence, Mass.

STEAM AND ELECTRIC TRACTION on the same tracks has been in operation on the Colorado & Southern Ry. for about 26 miles out of Denver, Colo., since May, 1908. No difficulty has been experienced in the operation of trains, and it has not been found that smoke or steam has in any way damaged the overhead construction. The electric cars operate a suburban and interurban service auxiliary to the steam train service.

THE ACCURACY OF GAS-ENGINE INDICATORS was investigated by Professor Frederic W. Burstall, M. Inst. M. E., in recent comparative tests of an optical and a spring indicator. A paper describing these tests was presented at the Liverpool meeting of the Institution of Mechanical Engineers, July, 1909. A Hopkinson optical indicator and a Crosby spring indicator were connected to the two branches of a special Y-shaped fitting so that both indicators were at the same time subjected to the pressure in the engine cylinder. The cylinder of the engine had a diameter of 16 ins., with 24-in. stroke and a speed of 165 r. p. m. Cards were taken simultaneously with four different regulations of the amount of gas admitted, giving mean effective pressures ranging from 78 to 103 lbs. per sq. in. Mean diagrams for each regulation were then plotted for each indicator by averaging the ordinates of twelve or more separate cards and the mean diagrams of the two indicators for each regulation were superimposed one upon the other in order to compare them.

The compression lines were found to be practically coincident within the error (1.4 lbs. per sq. in.) of measuring and plotting the diagrams. The maximum pressures practically agreed in two of the four tests; and in the other two the Crosby indicator gave the higher indication in one and the Hopkinson in the other, the difference being about 4% of the total initial pressure. On the expansion curve, the two indicators agreed for the first third of the stroke, after which the Hopkinson gave a higher expansion line, resulting in mean effective pressures about 3% higher than given by the Crosby.

Professor Burstall was of the opinion that neither friction nor inertia was likely to account for this persistent difference between the two expansion lines, but was inclined to attribute it to a slipping in its supports of the flat, bar spring of the optical indicator. His conclusions are as follows:

The results of these comparisons while not an absolute proof of the accuracy of either of the indicators, is still strong evidence that both are giving results very close to the truth. . . . In the optic indicator the inertia is certainly negligible; that the two give results agreeing to within 3% on the mean pressure and very nearly the same figures for the initial pressure, is good presumptive evidence that when either indicator is used with the precautions which have been described [The use of steel wire and phosphor-bronze stranded wire to replace indicator cord and the use of a heavy spring to control the tension in the wire.—Ed.] the results so obtained are at least as accurate as any other measurement which can be made in engine testing.

The Rolling of Special Sections of Iron and Steel.*

By WILLIS McKEE.†

The writer has been largely occupied in developing the possibilities of rolling steel into more or less complicated forms. The boundary between the possible and the impossible, between the practical and the impractical, is exceedingly flexible, for numerous reasons.

(1) Rolling mill men themselves do not know the possibilities of their own mills.

(2) New demands for large tonnage of certain sections justify the mills in preparing for such sections and experimenting with the same, when an order for a few

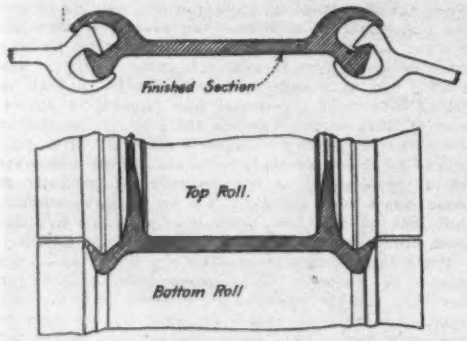


Fig. 1. Steel Sheet Piling Made by a Combination of Rolling and Bending Passes in the Rolls.

tons or even a few thousand tons would not in any way recompense the mill rolling them.

(3) New mills of new designs are opening up new possibilities.

(4) Often a proposition of some special section is not put up to the mill which is properly equipped with machinery and brains to handle anything out of the ordinary, or at least to handle the particular sections in question. The writer has been told by his rollers and roll designers, that certain things were impossible, because they had never seen them accomplished. The only way we were able to get around such opposition was to get new men, for as long as the mill men took that position they could block any scheme that came up. It is necessary to work on the supposition that everything can be done until it has been shown that it cannot be done.

Rolls are practically dies, which in revolving form the metal to their contour. It becomes necessary, therefore, to confine our rolled sections to such shapes that the rolls, in the last roll pass, will come in contact with the whole of the surface of the section to be rolled. This rule is apparently deviated from in the case of such sections as the interlocking steel sheet piling shown in Fig. 1. But this is not truly a deviation from the rule, as these sections are rolled so that the material can clear the roll, and then in the last pass no work is performed but in bending over the flange. In

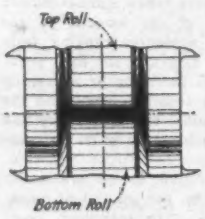


Fig. 2. Rolling I-Beams in the Ordinary Way.

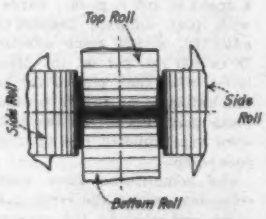


Fig. 3. Rolling Wide-Flanged I-Beams in the Grey Four-Roll Mill.

other words, it is rolled in such shape that the rolls can come in contact with all the section, and then it is simply bent over in a bending pass, in which there is no rolling or reduction.

Structural and bedstead tubing is formed up in a mill, but we would hardly consider that we rolled the tubing, although the piece leaves the mill in the shape of a tube. In reality we roll the skelp or flat strip of steel, and then form the same up into the round by means of bending rolls and guides, but there is no reduction of the section after beginning to form it up, so it is in reality a hot continuous bending operation, and not a rolling one.

Steel reinforcing bars for concrete have become a large tonnage proposition, and rolling mills have done all in their power to meet the demands of the engineer for bars that will at all points have practically the same area of cross-section, and at the same time have such irregularities as to properly attach them to the concrete. With the exception of sections (like the Kahn) which are slit after being rolled, and the twisted bars, practically all these sections are rolled on rolls that have had irregularities milled into them.

Rolling mill men naturally do not desire rollings of this kind, for the reason that they have to be equipped to finish their rolls in a milling machine and at an additional cost, and then on account of the nature of the rolls, it is impossible to roll a tonnage equal to that produced in plain rolls. It is also impossible, as a rule, to use a chilled finishing roll on such work, on account of the difficulty of finishing the same, and it is necessary to fall back on steel rolls, which will not last as long as chilled rolls, and which roughen up very soon. Of course, such little roughnesses on the concrete bar, are not usually regarded as serious. The twisted bar is rolled straight; in some mills it is twisted on the hot beds before it cools, while at other plants it is twisted cold.

Steel columns have for years been made in two ways. Small ones of a single I-beam, and the large ones of built-up sections, the point where it became expedient to change from one to the other being usually determined by the radius of gyration of the I-beam in the line of least resistance, the beam often being many times too strong in the other axis. It is impossible to overcome this in an ordinary beam, as the legs of the beam must have a decided taper (16⅔° being the usual practice) in order to clear the rolls, and it is impossible to make the flanges long. Fig. 2 shows one of the reducing passes. In this pass, the bottom flanges are being lengthened, while the top flanges are shortened, because the same roll is on both sides of these flanges.

The demand for an I-beam of practically square section led to the installation in Germany and afterwards at Bethlehem, Pa., of special mills to roll such sections. These mills are arranged with two sets of rolls in the same plane, but with axes at right angles, the one set forming the inside, and the other the outside of the beam (Fig. 3). In these mills it is possible to roll sections with long flanges, and with flanges whose sides are nearly parallel. It is claimed, with seeming justice, that the metal of the section rolled on such a mill is of a more homogeneous character than if rolled by the former method, because it is possible to make practically equal reductions in the several parts of the sections in the succeeding passes, so eliminating the tearing tendency which is natural in the old style rolling. Another advantage claimed is that the circumferential speed of the rolls at point of contact is always practically the same, while in other mills it is often nearly twice as great at some points as at others, causing slipping and distortion of the fiber of the steel.*

In Germany many sections of fancy molding are rolled and sold for prices ranging from $100 to $200 a ton. Such work has not appealed to American rolling mills, because there are but limited tonnages of each section, and also because the carving of the rolls for such work is laborious hand work. American mills are specialized mills, and they are almost all striving for tonnage. It is difficult for some people not in the business to understand why a mill should want $5 to $10 extra per ton for some special section, beside making the customer pay for the cost of the rolls.

When first interested in the manufacture of tie-plates, the writer noticed that there were two main types of these made of rolled steel. One with flanges on the bottom, and the other with a shoulder on the top to take the thrust of the rail. He could not see why there was not a fair chance, at least, of being able to roll a plate with both the shoulder and the flanges. There were a number of reasons given as to why this could not be done. One was that it would be impossible to reduce the section enough in one pass to get such a shoulder as was required. Another was that the roll itself would "spall" at the shoulder. The third, that the reduction in the body of the plate would be much more than it would be possible to put on the flanges, thus causing the flanges to break.

We experimented only a short while until we were convinced that we would be able to meet the demands of the engineers, but in order to do this, it was necessary to do what all our friends in the rolling mill business had told us was impossible. We rolled tie plates, ⅝-in. thick with a ⅝-in. perpendicular shoulder, and in order to do this, it is evident that it is necessary to reduce the section by over 50% in the finishing pass. In practice, this reduction is as much as 60 to 70%. To a mill man used to only 10 to 20% reduction in the finishing pass, this looked impossible.

There were found two troubles which bothered us. One was the irregularities between the shoulders. That is, that when rolling a bar of plate that was supposed to be 8 ins. between the shoulders, if the top and the bottom rolls were not properly pitched, and all other conditions were not perfect, there would be a slip in the rolling, so that one roll and then the other seemed to govern the speed of the piece. Again the r[illegible]ctions are so excessive that at times when a new an[illegible] roll is put in the mill, the speed of the piece will [illegible]onger be governed by the peripheral speed of the ro[illegible] with the result that some plates are only half of th[illegible]ength they should be. As knowledge of these condit[illegible]s has been gained, it has been possible to keep the[illegible]varia-tions within reasonable limits.

Another trouble was from the piece buckling a[illegible]t left the rolls. This seems to be caused by the differ[illegible]ce in the reduction on the bar at the shoulder and [illegible]other points along the bar. As it is absolutely necessa[illegible] that the foot of the rail should have a good bearing [illegible] front of the shoulder, at first we straightened every pi[illegible]e. It then occurred to us, that as the place a tie-plate [illegible]ually

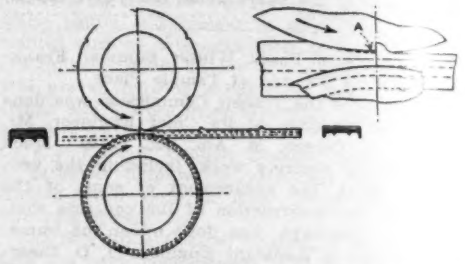


Fig. 4. Rolling Tie-Plates with Longitudinal Flanges and Transverse Shoulders.

failed was at the shoulder, it would be well to cut away the top roll, as shown by dotted line at A, Fig. 4. This left the plate flat on the top surface and with a swell or reinforcement on the bottom side. In this way and at the same time, we were enabled to get around our difficulty and have the plates reinforced at their weakest point.

In rolling sections of this kind it is of course necessary to make the controlling circumference of the rolls a multiple of the length you desire in the hot tie-plates. This is not as serious a matter in rolling tie-plates as it is in the rolling of reinforced splice-bars for rail joints, as the length of a splice bar is such that it is hard always to get a roll of the correct diameter.

Rail joint splice bars have demanded considerable rolling mill ingenuity. The bar for the Continuous joint (Fig. 5) is rolled with flanges turned out, and in the last pass it has been the customary practice in some mills to bend it into final shape, while in other mills it is bent into its final shape after it has been cut to length.

We have been requested many times to roll tie-plates and similar products having projections or grooves which were not in the direction of the rolling, and when the rolls for such sections could not be commercially machined by any process with which we are acquainted. Yet in a number of instances we have found other mills

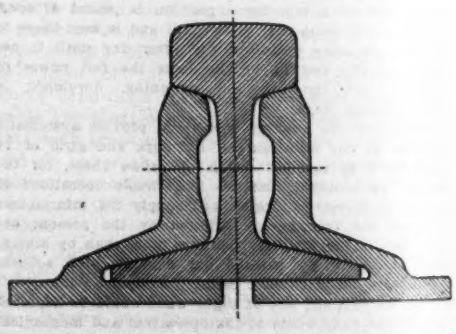


Fig. 5. Splice Bar Section Made by Rolling and Bending.

offering to roll such sections. This mistake is often made by the person looking at the section desired and figuring out how the rolls could be fashioned, without stopping to fully consider that the rolls are really the matrix for the section to be formed.

THE ELIMINATION OF A SWITCHBACK on a mountain section of one of the lines of the New South Wales Government Railways, near Lithgow, is being effected by the construction of a new line having easier grades and curvature. This involves very heavy and expensive work. The report of the Chief Commissioner of Railways for the year ending June 30, 1909, states that five tunnels have been completed and five more are under construction. Electricity is used for lighting the tunnel work and for driving the air compressors. The work on the tunnels has been greatly accelerated by the construction of a cable incline which enables materials to be lowered 350 ft. from the present line to the level of the new line.

*Abstract of a paper read before the Western Society of Engineers, Chicago, Sept. 1, 1909.

†Elyria, Ohio.

[*See article on "Tests of Standard and Wide-Flanged I-beams" in our issue of Aug. 12.—Ed.]

Electric Freight Locomotives of the New York, New Haven & Hartford Railroad.*

The announcement that the New York, New Haven & Hartford R. R. proposed to extend its 11,000-volt, single-phase, electric-traction system on four tracks from Stamford to New Haven, Conn., was briefly noted in Engineering News, June 24. At that time it was stated that preliminary freight and passenger service would be undertaken and that all freight as well as all passenger traffic into New York City eventually would be hauled by electric locomotives. The New Haven electric locomotives now in service were designed for high-speed passenger service and it has been necessary to develop a type to operate at lower speeds and higher tractive effort for hauling freight.

The Westinghouse Electric & Manufacturing Co., the contractors for the original system of the New Haven road, have now contracted to build the first of the freight locomotives. It is expected that this will be put into service on the New York—Stamford section in October. This first locomotive has been designed primarily, it is stated, for fast freight service though it may be employed at times for hauling the heaviest passenger trains. It will be capable of hauling a freight train having a maximum weight of 1,500 tons, at a speed of 35 miles per hour. When used in passenger service, 800-ton trains will be hauled at a maximum speed of 45 miles per hour.

The general arrangement of the locomotive is shown in the accompanying figures. These figures, on account of the small scale necessarily used, show some exaggeration of minor details.

MECHANICAL DESIGN.—The mechanical parts of this locomotive were designed by the engineers of the Baldwin Locomotive Works and the mechanical department of the New Haven Road, and are being built at the Philadelphia works of the Baldwin company. The general plan of trucks and running gear follows a patent granted to Mr. S. M. Vauclain, M. Am. Soc. M. E., July 6, 1909. This patent is for an articulated locomotive in which the truck frames are connected by an intermediate draw-bar. One truck has only a rotative motion about its center-pin, while the other has a fore-and-aft as well as a rotative motion, in order to compensate for the changed distance between truck centers when the locomotive is on a curve. The tractive force is transmitted through the truck frames and the intermediate draw-bar, instead of through the main frame. A 2-4-4-2 wheel arrangement has been adopted. Each truck has two pairs of driving wheels, and a single pair of leading wheels. The driving wheels are held in alinement by cast-steel bar frames, similar to those common in steam locomotive practice. The frames are placed outside the wheels as shown in Fig. 2, and are braced transversely under the center of the locomotive by heavy steel castings provided with draw pockets in which the intermediate draw-bar is seated. Train connections are effected by a radial draw-bar at each end of the locomotive. The draw-bars are pinned to cast-steel cross-ties, which brace the truck frames between the driving and leading wheels. The latter are mounted in radial-swing trucks, the radius bars for which are pivoted to the same cross-ties as are the main draw-bars.

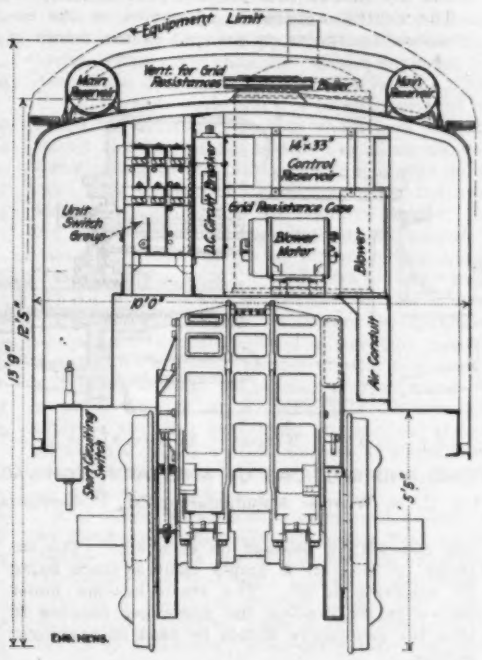


Fig. 1. Sectional End Elevation. New Haven Electric Freight Locomotive.

The wheel loads are equalized much as in common steam-locomotive practice. A part of the load on the leading wheels of each truck is thrown onto the springs of the drivers of that truck through equalizing beams. Also one truck is cross-equalized at the end under the center of the locomotive. This arrangement is designed to prevent side rolling at the higher speeds and generally promote steady riding.

The cab is built up of steel plate and, being 43 ft. 6 ins. in length, covers the entire locomotive. The frame which supports the cab is composed of two 12-in. channels, joined at the ends by plates and angles. This frame is braced transversely by five cast-steel cross-ties; one of these is over each truck center-pin, one is at mid-length, and one is near each end of the locomotive. The cab, with its load of electrical equipment auxiliary to the driving motors, is supported on the trucks at the end and intermediate cross-ties of the cab frame, the load being transferred through numerous coiled springs placed in pockets over the outer end and the center cross-ties of each truck frame. There are two springs over each end cross-tie and but 30 ins. apart while, over the center cross-ties of each truck, there are four springs, placed at the corners of a rectangle, 84 ins. apart transversely and 53 ins. longitudinally. The truck center-pins carry no weight and merely hold the cab frame in alinement. The spring pockets are free to slide over those cross-ties of the truck on which they bear. To assist in reducing shocks and alining the two truck frames, chafing castings and spring buffers are placed between these frames under the center of the cab.

Free use has been made of cast steel on the heavier details such as the truck frame and the cross-ties of the truck and cab frames. Approved steam-locomotive practice has been followed in many points of mechanical design. The principal dimensions of this locomotive are as follows:

Gage	4 ft. 8½ ins.
Driving wheels, outside diameter	63 ins.
Driving wheels, center diameter	56 ins.
Driving-axle journals	8 × 13 ins.
Truck wheels, diameter	42 ins.
Wheel-base, rigid	7 ft. 0 ins.
Wheel-base, total	38 ft. 6 ins.
Length between coupler faces	48 ft. 0 ins.
Height overall	13 ft. 9 ins.
Width	10 ft. 0 ins.
Approximate weight, total	260,000 lbs.
Approximate weight on driving wheels	188,000 lbs.

ELECTRICAL EQUIPMENT.—The electrical apparatus comprises four 300-HP. single-phase, geared motors, together with the auxiliary apparatus necessary for their operation from the 11,000-volt alternating-current or the 600-volt direct-current circuits of the electrified sections which the locomotive will traverse.

The motors are placed directly over the driving axles and are mounted solidly on the truck frames. On each end of the armature shaft is slipped a pinion; these mesh with gears mounted on a quill surrounding the driving axle and carried in bearings on the under part of the motor frame. At each end of the quill is a disk having six pins, or arms, which project into spaces between the spokes of the locomotive drivers. Each of these arms is connected to the end of a helical spring. The other end of this spring is connected to the locomotive driving wheel. The spring connection between the driver wheels and the disk on the armature-quill end, together with the large internal diameter of the quill itself, permits almost unrestricted change of relative position between driver axles and motors. The two pinions on each motor axle are also spring fastened to equalize the torque on them. The

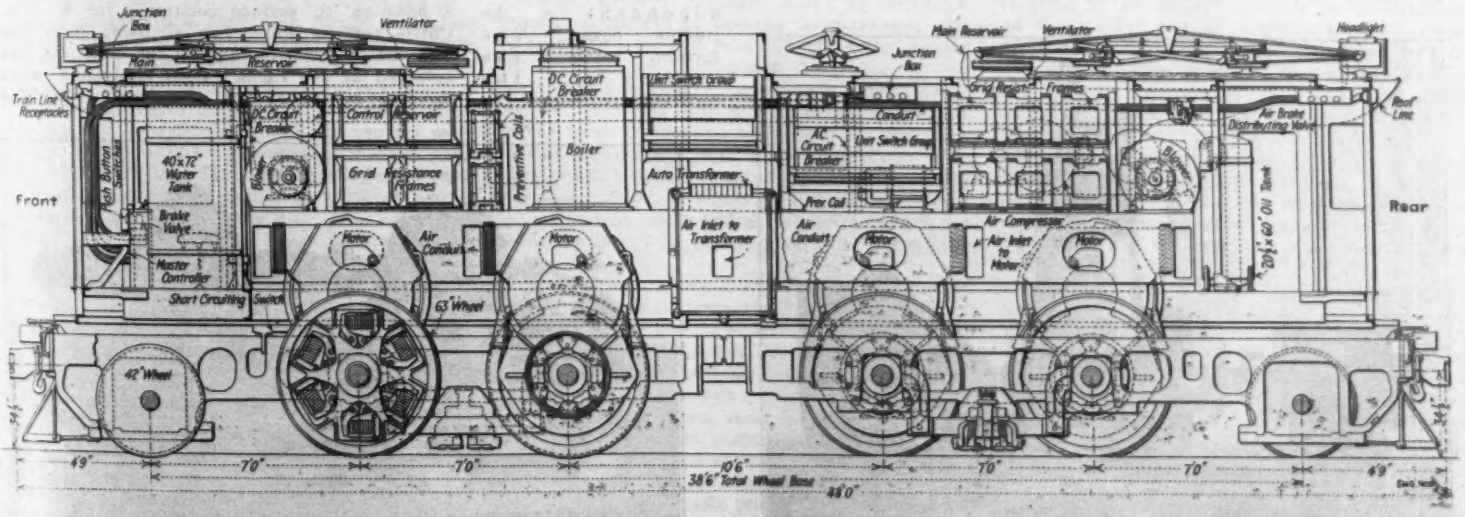


FIG. 2. LONGITUDINAL SECTION OF A SINGLE-PHASE FREIGHT LOCOMOTIVE FOR THE NEW YORK, NEW HAVEN & HARTFORD R. R.

(Built by the Westinghouse Electric & Manufacturing Co., and the Baldwin Locomotive Works.)

*From information furnished by the Westinghouse Electric & Manufacturing Co., Pittsburg.

center of gravity of the motors is placed high above the track by this arrangement and thus the transmission of abnormal stresses to the track is believed to be diminished from that obtaining with earlier electric locomotives.

This drive, by quills engaging the driving wheels, is a development of the system designed for the earlier New Haven locomotives, where the motors are not geared and the quill supports the armature and at the same time envelopes the driver axle. The drive on the earlier locomotives was briefly described in Engineering News, Sept. 5, 1907, and in greater detail in the issue of March 22, 1906.

The motors are a standary 12-pole type designed for forced ventilation. For operating on 25-cycle alternating current with forced ventilation, the motors are rated to carry continuously a load of 280 HP. Larger loads can be carried for a correspondingly shorter time. The trolley voltage is cut down, before reaching the motors, by a transformer, also cooled by air blast.

When operating on alternating current, all four motors are connected in multiple and the control is obtained entirely by changing the connections to various voltage taps on the main transformer. On direct current the motors are first grouped all in series, and then two in series and two in parallel, in combination with various resistance stops. Provision is made for cutting out any one of the four motors singly on either alternating current or direct current. The control apparatus is of the electro-pneumatic type, a master controller operating the unit switches which are located in the cab. A controller and air-brake valve are located in each end of the cab so that the locomotive may be operated from either end. By the use of a jumper connection two or more locomotives can be coupled together and operated from one controller.

Upon the roof are two pneumatically-operated pantagraph collectors for running on the high-tension alternating-current line. For running on the third-rail, direct-current system, the collector shoes shown are used normally, though a third, and smaller, pantagraph is provided on the roof or cross overs, etc. The third-rail shoes are thrown into position pneumatically.

The control apparatus, as shown in the accompanying figures, is grouped in the center of the cab with a passage on each side. The interior of the cab is amply lighted—there being 20 windows in all. The steam-heating boiler shown is for heating the passenger coaches in case the locomotive should be used in passenger service.

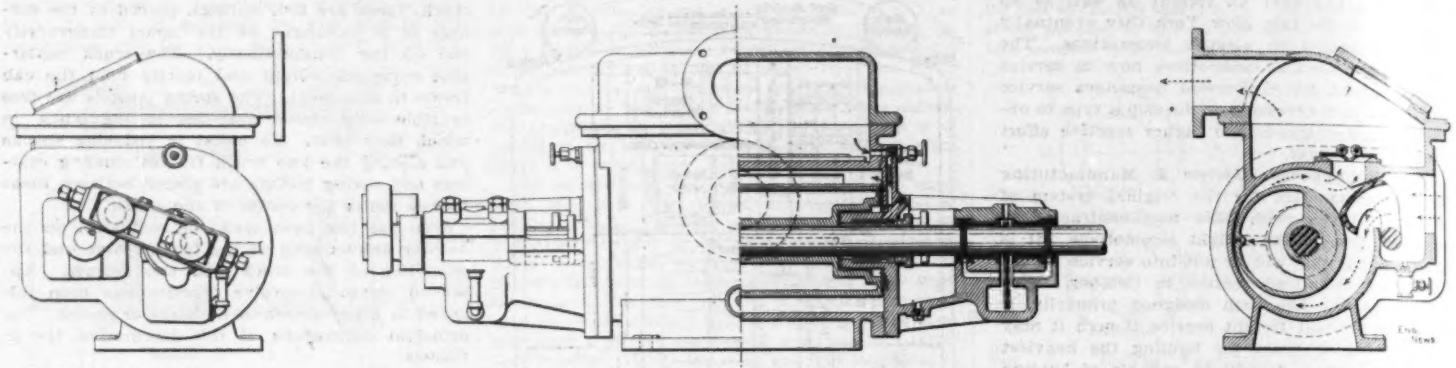


FIG. 1. ELEVATIONS AND SECTIONS OF A ROTARY HIGH-VACUUM AIR PUMP.
(The C. H. Wheeler Manufacturing Co., Philadelphia.)

A Rotary High-Vacuum Air Pump.*

Recent months have seen many efforts, among nearly all makers of condensing apparatus, to increase the efficiency and reliability of apparatus for maintaining very high vacuums at steam-turbine exhaust mains. Among the air pumps recently brought out, is an interesting design evolved by the C. H. Wheeler Co., of Philadelphia, and known as the "Rotrex."

The construction of this pump is simple as is seen from Fig. 1. There is a light cylindrical casing and a rotor eccentrically mounted on a heavy shaft, which is carried in outboard ring-oiled bearings. These bearings are entirely independent of the stuffing boxes. The division between the suction and the discharge spaces in the pump cylinder is maintained by a radius cam which is carried by a shaft working in bearings that are also independent of the stuffing boxes. The cam shaft is operated from the rotor shaft by a lever and crank on the outside of the casing, as seen in the end elevation of Fig. 1. By this arrangement, it is claimed, friction of internal contact is eliminated. The eccentric rotor swings around the pump-casing bore with a small clearance and the division cam is adjusted to give the same slight clearance at all times between itself and the rotor. These clearances are sealed by water fed from the discharge chamber as shown in the sectional elevation. Dotted arrows in this figure show the air discharge; the solid arrows show the flow of water for filling clearances. There are no rubbing contacts or sliding fits in the suction or discharge spaces anywhere. At the entrance to the discharge chamber is a pair of metal flap valves.

Fig. 2 shows a vertical steam engine direct-connected to a "Rotrex" air pump on one side and to a centrifugal circulating pump on the other side. Such units are designed to run at 180 to 250 r.p.m., according to the size. Owing to the high speed of operation, the dimensions for a unit of given capacity can be reduced greatly from those of the older types of air pumps. Fig. 3 shows a somewhat similar outfit driven by an alternating-current motor. In this figure the reverse sides of the air pump is shown compared with that shown in Fig. 3. The pumps are being manufactured in capacities of 50 to 5,000 HP. engine exhaust in a single unit. For sizes above 5,000 HP. multiple units are used direct-connected to a single driving engine.

The outfit shown in Fig. 2 was installed with a 3,000-sq. ft. surface condenser for 800-KW. Curtis turbine unit. The air-pump rotor was 12¾ ins. in diameter and 32 ins. long and was revolved at 240 r.p.m. With circulating water entering at 74° F. and discharged at 90° the vacuum maintained was measured on a mercury gage as 28.2 ins. Steam for a load of 775 KW. was being condensed. The barometer reading was 29.58 ins. and, assuming that the condensate left the condenser at 80° F., the theoretically obtainable degree of vacuum would be about 28.57 ins. Thus this pump maintained over 98% of possible vacuum.

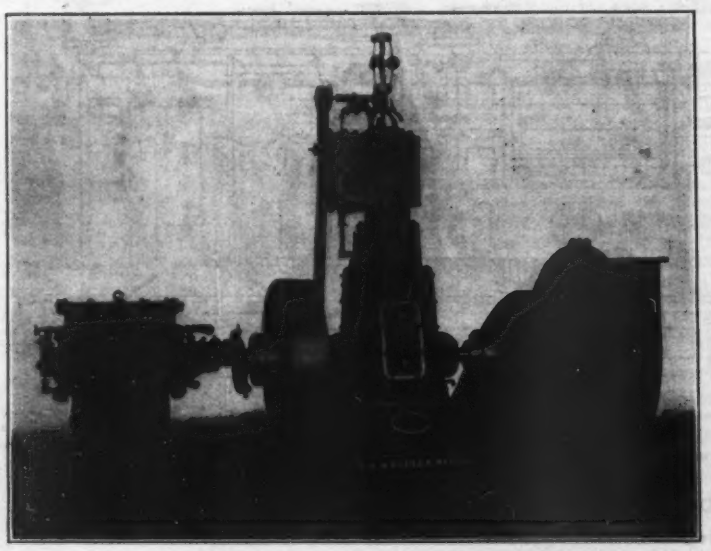


FIG. 2. ENGINE-DRIVEN ROTARY AIR AND CIRCULATING PUMPS.

FIG. 3. MOTOR-DRIVEN ROTARY AIR AND CIRCULATING PUMPS.

*From data and information supplied by the C. H. Wheeler Manufacturing Co., Lehigh Ave. and 18th St., Philadelphia.

Confusion as to Asphaltic Specifications.

By H. TIPPER.*

If some enterprising individual were to collect the specifications which have been written and printed for paving cement, asphaltic binder for roads, liquid asphalt, road cement and the hundred and one other combinations sold under the general term of asphaltic bitumen for the alleviating of the present painful condition of the roads, he would have a confusing conglomeration containing numerous contradictory assertions and statements.

The matter is called to mind particularly by the receipt of two specifications recently issued and published, one bearing the signature of a prominent road builder and both presumably intended to specify a material which would pass as a standard and would contain all the qualities necessary for road building, and only those qualities. In one of the specifications, which has been printed by a reputable engineering journal and scattered broadcast over the country, the forerunner of the actual specifications is a statement that even less is known of asphaltic oils, etc., than of tars. Nevertheless, there appears to be no hesitancy in appending to this statement a long and very exhaustive specification for such oils, going into considerable detail.

The writer is compelled to ask why it should be possible, in the engineering profession, for such a contradictory attitude to be maintained and for such specifications to be accepted and printed with all the authority of the author's name and the name of the paper, without the proper explanations which would seem to be necessary to reconcile the statements made. In short, where is the precedence in engineering for making such elaborate talk over something about which it is admitted we know nothing, or, at least, very little?

There are a number of points to which attention is called here, not for the purpose of discussing them, because they bear their own refutation on the face if examined with a little thought, but simply for the purpose of showing the present ridiculous status of this matter of specifications for material with which we are not familiar, of using tests the value of which we do not know and, consequently, of requiring a product the serviceableness of which we have no method of foreseeing.

The author of this specification, after asserting that the asphaltic oil should be uniform in its general character and contain no bodies not naturally present in asphaltic oil (which statement in itself is worthless, seeing that asphaltic oils in their crude state contain everything from the lightest oils to the asphalt, in varying proportions according to the different crudes), goes on to say, "It [asphaltic oil] shall not contain more than 0.5% of dirt or adventitious mineral matter." A little later, the same specification says, "It shall not contain more than 1% of matter insoluble in carbon bisulphide." The writer has always understood that there was only one method of ascertaining dirt or other non-bituminous matter in a residue of asphaltic oil or in an asphalt, this being an extraction with carbon bisulphide. If this is the case, it seems absurd to specify in one paragraph that the material shall contain not more than 0.5% of impurity and in a later paragraph that it shall not contain more than 1% of impurity.

The second paragraph in this specification calls for a specific gravity of not less than 0.97. There is undoubtedly some relation between the specific gravity and the quality of a binder, but no evidence has ever been given out or apparently adduced as to just what this influence may be. In this case it does not appear how any chemist or engineer should be entitled to include in his specifications a certain specific gravity for asphaltic material until such a time as evidence of the direct and actual value of such a test is established and its relation to the quality of a binder definitely known.

The third paragraph of this specification says that it shall not contain more than 10% insoluble in petroleum ether. This is also a point upon which the writer would like to have further information, since he has used bitumens the solubility of which in petroleum ether varied considerably and has been unable to decide, after considerable experience, as to what percentage insoluble in petroleum ether is necessary for such material.

The fourth paragraph in this specification states, "It shall contain no body that distills over at a lower temperature than 250° C. and shall not lose more than 55% by weight by distillation to 360° C." The high flash point is in such general demand for asphaltic oils that there may be some occult and inscrutable reason why it should be a determining factor in the binding quality of an oil. The writer has found, however, that two things are required in an asphaltic binder: (1) As much asphalt as possible; and by asphalt is meant bitumen soluble in carbon bisulphide of 100 penetration at 77° C. free from paraffine scale. (2) As much fluidity as possible at the working temperature. In order to obtain the maximum amount of asphalt with the greatest possible fluidity at working temperatures, the carrier should be as light as possible so that either (a) a given fluidity at working temperatures will allow a material containing the largest amount of asphalt, or (b) a given amount of asphalt will secure a material having the greatest fluidity at working temperatures.

A specification such as is mentioned, calling for no distillation below 250° C. means that all the lighter oils which are useful carriers have been eliminated and that what asphalt is contained is part of a residuum product loaded up with a heavy end, including some of the lubricants and the tarry residuums. Also, the question might be asked, "If this asphaltic binder will not show any distillation below 250° C., how can it be expected to reach such a consistency on the road at ordinary temperatures as will enable it to form a hard, elastic binding surface?" There is a conundrum in this for some expert at puzzles. If an asphaltic binder does not evaporate below 250° C. in a distillation test, how long will it take such a semi-liquid binder to become hard like asphalt pavement under air temperatures? The writer confesses that the puzzle is too much for him.

A viscosity test is mentioned in this specification, it being stated that the material shall not be less than five minutes nor more than ten minutes in passing through an orifice of $^{5}/_{16}$-in. diameter, under a head of 4¼ ins. at 100° C. Another question appears pertinent here. If maximum fluidity is desired at working temperatures, why should there be any minimum viscosity stated? If we could get a material containing 90% of asphalt which would pass through a viscosimeter at 100° C. in one minute, it would be very much better to work with and would produce very much better construction than a material which takes five or ten times as long. The maximum viscosity is necessary, evidently, inasmuch as too slow a movement at working temperatures means absolute failure in construction, but why a minimum viscosity?

There are probably on the market now eight different kinds of apparatus for testing asphalt melting point, and three or four for penetration tests. Three or four flow tests and innumerable other methods of making tests are also in use. It would be interesting to know why every chemist seems to feel obliged to create a special apparatus for these purposes and put it out in his specifications to the utter confusion of the engineer and the absolute impossibility of securing any comparable results.

The following sentence from the specification denotes a test of which it is difficult to see the value: When 20 gms. are heated in a flat-bottom dish, 3 ins. in diameter, for 21 hours in an oven at a temperature of 100° C., it shall not lose more than 5% by weight. An earlier requirement in this specification says that the material shall not distill over at less than 250° C. Hazy memories of technical training seem to indicate that distillation is a matter of evaporation and recondensation. Therefore, if there is no distillation below 250° C., why is it necessary to call for a test at 100° C. and specify not more than 5% loss in this test, if the material does not lose any at all below 250° C.?

The last test mentioned in this remarkable document (which, however, is typical of all the other remarkable specifications in the asphalt business, there being hardly any which are not remarkable) is not a test at all. It is of such a description that its value and the actual decision regarding it must lie between heaven and the operator. A court of arbitration would be necessary to decide on whether a material would pass this test or not. This test reads that when 12½% by weight of material is mixed with 87½% by weight of sand and made into briquettes 3 × ½ in., these briquettes must keep their shape and show some binding together. It is not stated whether they should hold together for five minutes, a week or a month, or whether they should be so bound as to withstand a tension strain of two pounds, twenty pounds or one hundred pounds. The test is meaningless and worthless.

The same specification includes a specification for "oil asphalt." Here is another of the obscure points on which information would be highly desirable. When is an asphalt anything other than an oil asphalt? The present theory as to the natural production of asphalt is that it is produced by the natural reduction of oil (unless this theory has changed within the last week or so) having been occasionally subjected to excessive heat and pitched in the process of reduction.

Another noteworthy statement in this specification is included in the one for "oil asphalt," which states it shall contain no body that will distill at a lower temperature than 225° C. If reference is made to the specification on asphaltic oil, it is found that this oil is not expected to distill at less than 250° C. Why should it be necessary to specify a higher distillation test for asphaltic oil than for asphalt which is a further reduction of the oil by distillation?

A specification such as the above is apparently made from the results of a few tests on a particular product which the writer of the specification has had through his hands and, even in that case, the tests are not very well chosen as regards their indicative value. It is evident, however, that, whether this is so or not, no engineer or chemist worthy of the name is entitled to take the results of a series of tests on some particular product and establish a specification from these tests which is to be adopted for the securing of the proper materials for construction on the market and is therefore to that extent supposed to be standard. Such a procedure is only calculated to make the engineering profession look ridiculous. To the spectator it would almost seem that the poor chemist who was instructed to issue this specification, being at a loss what to say on account of our ignorance as to the nature of asphaltic bitumens, in his embarrassment, took the first analyses which he happened to be acquainted with and issued them as a standard of what was most desirable for the work.

The fact appears to be that the term "specification" in regard to the asphaltic materials has been altogether misused. In other branches of engineering the word "specification" includes the definition of the qualities which the material is required to have in order to meet the condition of work, and the tests to which it will be subjected to show that those qualities are present to the required degree.

Asphalt specifications, on the other hand, appear to be largely descriptive. They describe some material or materials which have been taken as a basis. They do not describe necessary road-building qualities, nor are the tests indicative of any such value in many cases, nor can they be connected with any such values. The suspicion is naturally entertained that such specifications are not the result of independent investigation by engineers, and it is difficult to see how the road engineer can consider himself free from a possible charge of neglect or ignorance where this condition prevails. It is very evident that we are ignorant as to the nature of asphaltic oils and the required materials for

*Publicity Engineer, The Texas Co., 17 Battery Place, New York City.

road building. Why is it not possible to say so frankly and omit all these tests about which nobody knows, or seems to know,—about which there is no evidence of experience.

The specification referred to has been taken as a typical specification and is very similar to a number of others which have been examined by the writer, all of which have contained a great many points of doubtful value. It will naturally be asked, after such a criticism of the present condition of affairs, "Have you any remedy to suggest?"

SUGGESTED ASPHALT SPECIFICATIONS.—The following suggestions were made at the recent meeting of the American Society for Testing Materials by Dr. Albert Sommer, who is the consulting chemist of the Texas Co. They are made as a basis for consideration and attempt to describe only such tests as can be shown at the present time to be determinative of actual road-building value, all other tests having been eliminated. Criticism of these tests is, in turn, invited, as the desire of the author is to secure as much light upon this subject as can be obtained, in the endeavor to reduce the specifications of road materials to such a basis as will be consistent with the standing of the engineering profession:

(A) It shall contain as much as possible of asphalt of suitable consistency for building the road.

(B) It shall be as fluid as possible in order to enable it to be properly applied by the method proposed.

(C) For this reason all products must be eliminated *a priori* which would increase the viscosity without increasing the percentage of asphalt.

(D) A compound, therefore, must be chosen which has been made from a solid asphalt by using a rather light flux. The flux shall contain no lubricating or paraffine oils and shall be used only as a carrier. It should either evaporate or seep into the stone or mineral aggregate upon application, thus making the compound set up rapidly after it is on the road.

That cold stone will be applied in most cases seems to be a foregone conclusion. For this reason a solid asphalt will in most cases be out of the question. No matter, however, what mixing method should be finally decided upon, at any rate a satisfactory asphaltic material must comply with the above requirements.

As to specifications which are in accordance with the above suggestions, the following is a sample:

A Specification Proposed for a Macadam Binder of 80% Asphaltic Contents.

(1) It shall be soluble in bisulphide of carbon to not less than 99.5%.

(2) It shall be soluble in carbon tetrachloride to not less than 99.5%. (Solubility in tetrachloride indicates absence of so-called "carbenes" which are always an indication that the asphalt has been overheated.)

(3) When heated to a temperature not exceeding 500° F. until 20% are evaporated, the residuum shall have a penetration of not more than 10 mm. when tested with a No. 2 needle, weighted with 100 grs. at 77° F. on the Dow machine.

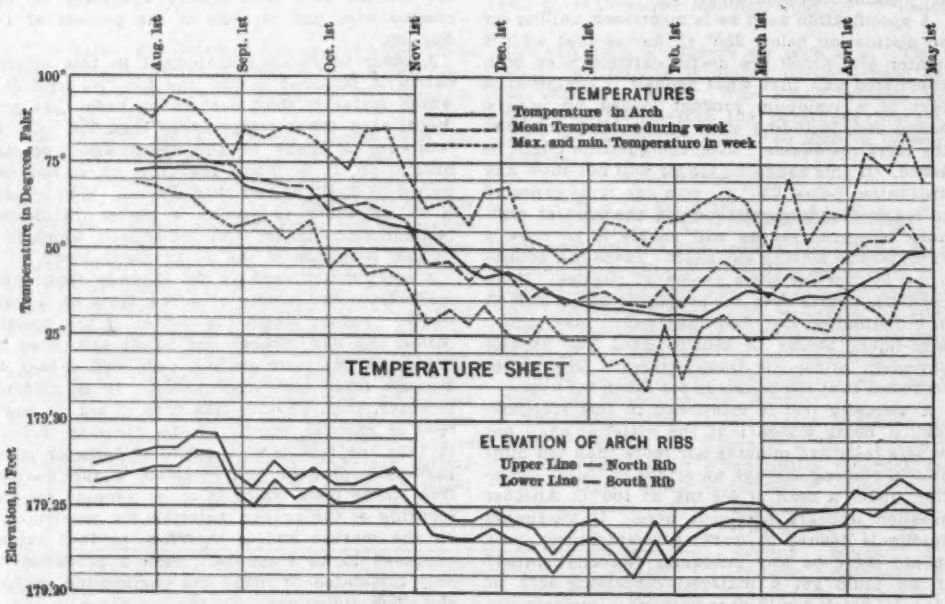
(4) The compound shall be sufficiently liquid at working temperatures so that when tested in an Engler viscosimeter at 212° F., 50 cu. cms. shall not take more than 200 seconds to flow out.

(5) The solid contents of this material should consist only of asphalt and the consistency of the residue shall not be due to any other solid substance, such as paraffine. The paraffine scale of the total compound shall not exceed 1%. Paraffine scale is to be determined by destructive distillation of the entire compound to coke, and determination of the paraffine scale in the distillate by the Holde method.

(6) The asphaltic binder shall not contain any dirt or water, but shall consist of pure bitumen only. Tar or substances recovered from acid sludge shall not be admitted.

The Effect of Temperature on the Walnut Lane Concrete Arch.

In a recent paper* before the American Society of Civil Engineers there is given the result of a very interesting series of observations of the effect of changing temperature upon the arch rings of the main arch of the Walnut Lane Bridge, across Wissahickon Creek, in Philadelphia, Pa. This arch, as most of our readers will remember, is made up of two parallel arch ribs, each of 233 ft. span, 70 ft. 3 ins. rise and 18 ft. width, spaced 34 ft. c. to c., and carrying on spandrel walls, with cantilevered sidewalks, a 60-ft. roadway. At the crown each rib is 5 ft. 6 ins. deep and at the spring 9 ft. 6 ins. The entire arch is of mass concrete, with solid square ends and no hinges.



TEMPERATURE RECORD ON WALNUT LANE BRIDGE, PHILADELPHIA.

Some time after the completion of the arch, an electric resistance thermometer was embedded in one of the ribs on the mid-line near the spring, and weekly observations were made upon the temperature of the heart of the concrete. The results of these observations, together with the outside temperature and the variations of the elevation of the arch crown, all between the months of Aug., 1908, and May, 1909, are given in the accompanying diagram, which is self-explanatory. The dotted line temperatures are the records of the local Weather Bureau; the solid line those of the encased thermometer.

Study of this diagram will show that there is very close adherence to the mean outside temperature by the inside of the concrete, and also that the rise and fall of the arch closely follows the thermometer.

In computing the temperature stresses in the arch, previous to its erection, it was assumed that there would be a change of temperature of 40° F. in the rib either way from the prevailing temperature. The diagram shows that a variation of 42.8° F. actually occurred in the time observed. The actual temperature of keying the two ribs is not known, although it is thought that one was within 10° or 15° of the high temperature and the other at about the mean. However, the range is remarkably close to that previously assumed. The variation in height of the arch rib was computed to be 1 in. at the crown, and the diagram shows this value actually to have been 1⅛-ins., another close adherence.

*Walnut Lane Bridge, Philadelphia. By George S. Webster and Henry H. Quimby, Members Am. Soc. C. E. Proceedings Am. Soc. C. E., Aug., 1909, p. 586. Presented Sept. 15, 1909.

A Railroad's Correspondence Course for Employees.

On Aug. 20, the Union Pacific R. R. Co. announced the establishment of an "Educational Bureau of Information" to (1) assist employees to assume greater responsibilities, (2) increase the knowledge and efficiency of employees, (3) prepare prospective employees for railway service. A few days after this announcement a circular was issued describing the operation of the "bureau." From this circular the following extracts have been taken to show the main lines of development of this latest of correspondence schools. There are at present 124 students enrolled and this number is rapidly increasing.

ASSISTING EMPLOYEES TO ASSUME GREATER RESPONSIBILITIES.—The bureau will offer any employee, desiring to qualify himself to assume greater responsibilities, a course of reading and study along the line which he may indicate. This course will be conducted somewhat on the method of now existing correspondence schools, and will be prepared with special reference to the needs of the particular case. This course need not necessarily be confined to the particular work of the department with which the employee is connected, but may embrace any subject, the knowledge of which may be of value to the employee in the position now occupied or which would help to qualify the employee to change positions to a line of work which would be more nearly suited to the ambition or desire.

An employee taking up a special line of work of this kind must show his interest in it by doing a reasonable amount of reading or studying. Otherwise, the company will not be justified in continuing the expense of maintaining the employee on its student rolls.

Those selected for advancement to minor official positions will be afforded an opportunity, before formal appointment is made, of acquiring a knowledge of the practical workings of such departments as they have not been intimately connected with, through a temporary connection therewith under the direction of the heads of such departments, and at a salary fixed by the Board of Supervisors.

INCREASING THE KNOWLEDGE AND EFFICIENCY OF EMPLOYEES.—This bureau offers to all employees the opportunity to increase their knowledge, thereby increasing their efficiency, by means of the information department feature. Employees desiring information on any problem or proposition connected with their work, or on railroad matters in general, can, without any formality, address this bureau, stating the information desired. Name and address, position or occupation, division, district, office or shop where employed should also be stated.

This information will be furnished promptly and in as simple and practical a manner as possible.

All inquiries will be addressed to the Chief of the Bureau of Information, but any inquiry requiring special departmental information will be referred to the member of the Advisory Board best qualified to give the information desired, it being the intention to have all inquiries answered in such a manner that they will in nowise conflict with the instructions, ideas or precedents of the department to which they relate. Questions referred to members of the Advisory Board will not carry the names of the employees desiring the information, although a record will be kept available to the heads of departments wishing to know whom of their employees are seeking to increase their knowledge of railroad matters.

It is the intention to further this work by means of lectures on live railway subjects, to be given from time to time at various district headquarters. Pamphlets and reports will be distributed periodically, containing information on subjects of interest. Classes will be organized at various points to teach important subjects, and a representative of this bureau will be continually on the road to handle matters which cannot be properly explained or demonstrated by correspondence.

PREPARING PROSPECTIVE EMPLOYEES.—This bureau will be glad to register the names of dependents or relatives of employees who wish to enter the service

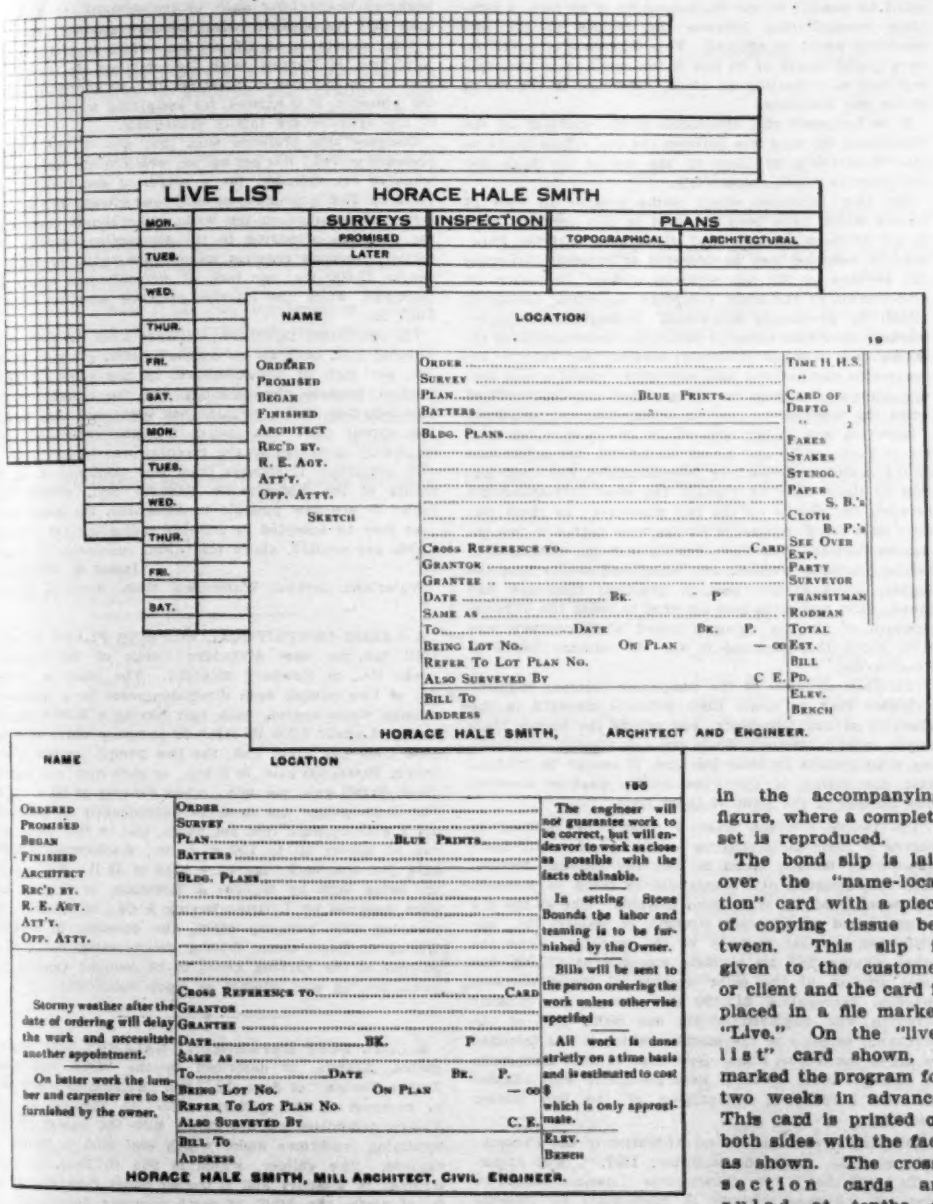
of the company, and will also keep in touch with various universities, colleges, high schools and technical schools for the purpose of having at all times material on hand to supply help desired by any of the departments. Persons registering with this bureau may indicate the particular line of work which they desire to follow. They will be given every opportunity for learning the elementary methods and requirements of the department they wish to enter, and while it is not promised that positions will be given to all applicants, it is, however, expected that the various departments will avail themselves of this opportunity for filling vacancies in their ranks from individuals registered with this bureau, who have taken advantage of the opportunity to qualify themselves for the positions desired.

A Civil Engineer's Office System.

By HORACE HALE SMITH.*

The writer having noted the articles on engineering-office systems appearing in Engineering News from time to time, has thought the system, devised for his office and successfully used there for three years, would be of interest to others and worthy of record.

It is wholly a card-file system, having four styles of cards and one bond-paper slip, all 6 × 4 ins. in size. These supplant all account, record, field and note books. The arrangement is shown in the accompanying figure, where a complete set is reproduced.



THE CARDS OF AN ENGINEERING-OFFICE RECORDING SYSTEM.
(Horace Hale Smith, Lawrence, Mass.)

The bond slip is laid over the "name-location" card with a piece of copying tissue between. This slip is given to the customer or client and the card is placed in a file marked "Live." On the "live-list" card shown, is marked the program for two weeks in advance. This card is printed on both sides with the face as shown. The cross-section cards are ruled at tenths of an inch and are used for all level, survey and field notes and for all calculations, whether made in the field or office. The peculiar advantage found with these cards over a note book is that the field party takes out with it only the cards showing the work in the vicinity of their surveying, instead of being encumbered with a large number of note books. All cards not in such immediate use are filed in the office where the draftsmen can plot from them, not having to wait until note books are returned to the office by the surveying party. The cards are filed by each job under the customer's or client's name and it is not necessary to search for data through several note books which are carried along more or less chronologically. The files are arranged alphabetically, forming their own index. The locality of work done is cross indexed on a city atlas, but without numbering. The ruled cards are used for such entries as "deeds," "cash," "bills issued" and "monthly-time accounts."

It has been found convenient practice in the writer's office to make plans 16 × 24 ins. wherever possible, and falling that, of dimensions which are some larger multiple of 8 ins., the plans being folded to 16 × 24. All plans are filed flat unless over 24 × 48 ins. in size, in which cases they are rolled. A blue print, of every tracing made, is kept in a fireproof vault for protection against the loss of plans.

This system, here very briefly outlined, has saved the time of a bookkeeper and of one man out of every four for the drafting room.

*Lawrence, Mass.

CONTROL OF BUREAU.—The privilege of using this Bureau is open to all departments and employees free of any charge, the company maintaining the bureau for the benefit of the entire service.

The work of the bureau will be controlled by a Board of Supervisors, consisting of the following officers of the company:

Vice-President and General Manager;
Freight Traffic Manager;
General Superintendent;
Chief Engineer;
Superintendent Motive Power and Machinery.

An Advisory Board, consisting of employees selected from the various departments, will act with the Chief of the Bureau in handling all questions relating to their respective departments.

All communications will be addressed to "Chief, Bureau of Information, Pacific Express Building, Omaha, Nebraska."

Calibration of the 2,400,000-lb. Hydraulic Testing Machine of the Phoenix Iron Co. at Phoenixville, Pa., by Comparison with the Watertown Arsenal Emery Machine.

The results reported below, of tests made for calibrating the 1,200-ton Phoenixville testing-machine by comparison with the 400-ton Emery machine at Watertown Arsenal, controvert the objections made to the accuracy of test results obtained with the Phoenix machine. As this machine weighs its load only by gage readings of the pressure in the hydraulic cylinder—which when multiplied by area of piston gives the total pressure acting against the piston—there is a deduction to be made for the friction of the piston-packing. Usually the deduction has been assumed to be very small, in fact negligible. The correctness of this has been in dispute, however, almost entirely because of a calibration made for the Department of Buildings of New York City twelve years ago (reported in our issue of Jan. 13, 1898, pp. 27-28), which appeared to show that the Phoenix machine has an enormous friction error, 15 to 17%. This is now proved to be wrong by the new calibration, made by Mr. J. E. Howard, Testing Engineer at the Watertown Arsenal. Mr. Howard's well-known accuracy and thoroughness of working should make the present results completely conclusive.

One of the results of this calibration is to throw clearer light on the test of a miniature model of the Quebec Bridge compression chord, made two years ago and reported in our issue of April 23, 1908. The test of that chord gave an ultimate strength of 26,850 lbs. per sq. in.; with a 17% reduction for friction this would be brought down to something over 22,000 lbs. While the latter figure is in better harmony with the stress at failure in the chord which caused the Quebec Bridge to collapse, Mr. Howard's calibration shows that we must take the larger figure, i. e., the model chord is to be credited with the full strength of 26,850 lbs. per sq. in. Similarly, a second (modified) model chord tested at the same time is to be credited with the full indicated strength of 37,000 lbs. per sq. in.

Mr. Howard's report follows, substantially verbatim.

The testing machine of the Phoenix Iron Co., at Phoenixville, Pa., has been compared with the Emery testing machine at Watertown Arsenal, Mass., by means of a nickel-steel modulus-of-elasticity cylinder, and by companion tests of a number of steel plate-and-angle box columns.

The tests at Phoenixville covered a range of stresses up to 2,258,900 lbs. compression, the tests being made on different occasions covering an interval of time of five months, from June to October, 1908.

Twelve steel box columns were fabricated by the Phoenix Iron Co., in three series of four columns each. Two of each series were tested at Watertown Arsenal, while the other two columns of each series were tested at Phoenixville. The columns were tested with pin ends, under conditions alike at each laboratory. The nickel-steel modulus-of-elasticity cylinder was loaded alternately at Watertown and at Phoenixville.

The readings of stresses on the Phoenixville machine were made with two Shaw mercury-column gages, a low-pressure and a high-pressure gage, respectively, each connected with the main hydraulic cylinder of the testing machine. The readings of stresses at Watertown were made with the usual Emery hydraulic weighing mechanism.

The measurements of strains at each laboratory were

TABLE I.—COMPARATIVE TESTS OF NICKEL-STEEL CYLINDER AT WATERTOWN ARSENAL AND AT PHOENIXVILLE.

(The test-cylinder was 10 ins. in diameter, 36 ins. long, and had a central longitudinal bore measuring 3.088 ins. diameter at one end and 3.086 ins. at the other. The sectional area of the cylinder was 71.055 sq. ins. Gage length 30 ins., symmetrical with ends of cylinder. Compressometer applied in succession along (1) top element of cylinder, (2) and (3) the sides (at the extremities of a horizontal diameter), and (4) the bottom element, as indicated by arrows in table.)

PHOENIXVILLE TESTS.

Low-pressure Gage Used.

Gage reading.	Applied loads in pounds. Total.	Per sq. in.	Compression readings on different elements. ↓	←○	→○	○ ↑
50	161,350	2,271	.0091	.0092	.0097	.0582
250	806,750	11,354	.0917	.0907	.0895	.0473
Differences,		9,083	.0074	.0085	.0102	.0109

Mean compression .00925 for load of 9,083 lbs. per sq. in., on gaged length of 30 ins. Value of the modulus of elasticity according to these figures:

$$E = \frac{9{,}083 \times 30}{.00925} = 29{,}458{,}000 \text{ lbs. per sq. in.}$$

High-pressure Gage Used

			↓	→○	←○	○ ↑
300	968,100	13,624	0.	0.	0.	0.
700	2,258,900	31,791	.01763	.01887	.0177	.0190
Differences,		18,167				

Mean compression 0.0183-in. for load of 18,167 lbs. per sq. in. on gage length of 30 ins. Value of the modulus of elasticity according to these figures:

$$E = \frac{18{,}167 \times 30}{.0183} = 29{,}782{,}000 \text{ lbs. per sq. in.}$$

WATERTOWN ARSENAL TESTS.

Corresponding Phoenixville gage reading.	Applied loads in pounds. Total.	Per sq. in.	↓	←○	→○	○ ↑
10	32,270	454	0.	0.	0.	0.
250	806,750	11,354	.0100	.0107	.0106	0.0119
Difference,		10,900				

Mean compression 0.0110-in for load of 10,900 lbs. per sq. in. on gaged length of 30 ins. Value of the modulus of elasticity according to these figures:

$$E = \frac{10{,}900 \times 30}{.0110} = 29{,}730{,}000 \text{ lbs. per sq. in.}$$

made with the compressometer in common use at Watertown.

As regards duration of time and the manner of using the compressometers the same conditions prevailed at each place. A large number of compressometer readings were taken on the test pieces, under different loads at each laboratory, with concordant results.

The total pounds load with the Phoenixville machine was obtained by multiplying the gage readings in pounds by the factor 3,227, the number of square inches area of the cylinder of the testing machine.

The tests of the nickel-steel cylinder gave results as stated in Table I.

The dimensions and make-up of the twelve built box columns are given in Table II.

The tests of the twelve columns gave the following results: The aggregate pounds ultimate strength of the six columns tested at Phoenixville was 4,149,115; of the six columns tested at Watertown 4,194,300 lbs.

It has been found that it requires a force of 12,000 lbs. to run the piston free back and forth in either a tensile or compressive direction at the Phoenixville machine.

As a means of rating a testing machine of large capacity a modulus-of-elasticity cylinder affords a satisfactory opportunity. The modulus of elasticity of steels of ordinary composition is found a nearly or quite constant factor, and its value is in the vicinity of 29½ to 30 millions. No serious error would be made in the rating of a large machine by reference to well made observations

TABLE II.—DIMENSIONS OF BUILT STEEL BOX COLUMNS TESTED AT WATERTOWN ARSENAL AND AT PHOENIXVILLE.

Marks.	2 Web Plates.	2 Cover Plates.	4 Angles.	Section sq. in.	L/r
C 2 A	8″×½″	10″×⅝″	2″×2″×¼″	14.13	55.3
C 2 B	"	"	"	"	"
C 3 A	9″×⅝″	11⅛″×⅝″	2¼″×2¼″×⅝″	18.9675	47.5
C 3 B	"	"	"	"	"
C 4 A	10″×⅝″	12½″×⅝″	2½″×2½″×⅝″	22.406	44.1
C 4 B	"	"	"	"	"

Tested with pin ends; diam. of pins, 7 ins.; lengths c. to c. pins, 14 ft. Values of L/r taken perpendicular to axes of pins.

on the strains of a modulus-of-elasticity cylinder or bar, and the converse is equally true that the stress on a member may be accurately judged of by a careful measurement of the strain induced. It is important, however, that the strains observed represent the mean strains of the cylinder, provided it is not uniformly strained along each element. The mean strain and stress bear a nearly or quite fixed relation to each other, and any error of rating or calibration made by means of such a bar will be one of very limited magnitude.

Now it appears in the comparison of these two testing machines, that the values of the modulus of elasticity of the nickel-steel cylinder as computed from the mean strains measured when the cylinder was in either machine differ but little. So little in fact that were the mean strains found in the Watertown machine changed by so small an amount as one tenthousandth of an inch, a complete reconciliation between the results of the two machines would be effected. This difference of 0.0001-in. on a gaged length of 30 ins. is too small to be seriously regarded as indicating an actual difference in the rating of the two machines.

It so happened that the value of the modulus on the Watertown machine was between the two values found on the Phoenixville machine, by the use of the high and low-pressure gages, respectively.

The only inference which seems possible in view of results which have been obtained in this carefully conducted series of tests is that *the readings of the Phoenixville machine may be accepted as reliably indicating the stresses on the test material, without correction or modification of the same, excepting the initial resistance 12,000 lbs. previously mentioned.* It may further be remarked, since this series of calibration determinations extended over a period of several months, that there is assurance of the uniform behavior of the machine and that variations in the same are not expected to be encountered when the machine is used on widely different occasions.

Referring now to the tests of the twelve steel columns, six at Phoenixville and six at Watertown, the indications of the modulus-of-elasticity determinations find confirmation in these tests as regards the close correspondence between the results on the two machines. In these column tests the Phoenixville results were higher in two instances than the Watertown results with the same type of column, in three instances the Watertown results were the higher, while in one case no practical difference was found. The aggregate load required to reach the ultimate strength of the six columns tested at Watertown was 1.1% above that required in the six columns tested at Phoenixville.

Inasmuch as some of the companion columns required a higher load to attain their ultimate strength in the machine at one laboratory, and others the higher loads at the other laboratory, while one pair yielded practically the same results in each machine, it cannot be inferred that the rating of the Phoenixville machine requires modification in the light of these tests.

The twelve columns make a remarkable showing in regard to their uniformity in strength, and a still more noteworthy feature found is that the heaviest section, C 4, was designed at Phoenixville to reach in strength the capacity of the Watertown machine. One of the C 4 columns had an ultimate strength of 800,000 lbs., exactly the nominal capacity of the machine, while the other column had an ultimate strength of 810,000—the total amount of the poise weights of the Watertown machine aggregating 811,100 lbs.—that is an ultimate strength was displayed within one 800th part of the maximum capacity of the machine which it was intended to tax to the utmost limit. By reason of their uniformity of strength these columns were peculiarly well adapted for the purpose of comparison of the two testing machines.

Referring now to an earlier calibration of the Phoenixville machine, made in December, 1897, it was apparently found that a very considerable allowance should be made in the gage readings to compensate for internal resistances. Based upon a limited number of compressometer readings, which were taken along one element only of an eight-segment Phoenix column, the results indicated that a correction of 17.1% was necessary to make proper allowance for such resistances. There can be no doubt but that those earlier measured strains failed to show the actual mean compression of the column and gave rise to an exaggerated conception of the extent of the friction of the machine. So extravagant was this estimate of the frictional resistance, that it is remarkable that the results were taken seriously.

Taking 17.1% of 800,000 lbs., the rated capacity of the Watertown machine, we have 136,800 lbs. Now this is from fifteen to twenty times the frictional resistance which has been observed on the Watertown machine. At Watertown check readings may be taken of the cylinder pressures independent of the regular weighing mechanism, the difference between the two representing the frictional resistance of the piston and the attractive force of the pulling head combined. On this basis a force equal to one-half the power of the Watertown machine would be required to move the piston of the Phoenixville machine against its frictional resistance, if the latter machine were used up to its full capacity, a state of affairs manifestly improbable.

It has been repeatedly noticed at Phoenixville that a correction so great as the earlier examinations seemed to call for, seriously disturbed the relation which is known to exist between the results of specimen tests and the tests of full sized members.

To inquire more closely into the conditions which would satisfy the requirements for a frictional resistance of 17.1%, let us consider the case of a load of 2,400,000 lbs., the full load of the machine, which would require a cylinder pressure of 743.7 lbs. per sq. in., the diameter of the cylinder being 64.1 ins., its circumference 201.37 ins., and its sectional area 322 sq. ins. If we assume a coefficient of friction of 17.1% the same as above for the packings against the walls of the cylinder, then it follows that the outward radial pressure necessary to cause a total resistance of 410,400 lbs., which is 17.1% of the total load, is identical with the total load on the piston, that is the full load of 2,400,000 lbs.; an enormous bursting pressure, if it existed, for sustaining which the walls of the cylinder are totally inadequate.

Compare this pressure with that due to the interior pressure of 743.7 lbs. per sq. in., which latter gives on the walls of the cylinder, for a length of one inch, 64.1 × 743.7 = 47,671 pounds, or only one-fiftieth of the concentrated pressure on the walls which should come from the packings according to the assumptions made. The former condition requires an outward radial pressure of nearly 12,000 lbs. per inch of circumference under the packings, while the interior pressure amounts only to 743.7 lbs.

The resistance, 12,000 lbs., observed when the piston was running free, calls for an outward radial pressure of 348 lbs. per inch of circumference, on the basis of 17.1% friction between the packings and the cylinder walls. The behavior of the machine has been such that it does not appear that this initial frictional resistance was materially increased as the machine was loaded.

In conclusion it appears from this examination of the rating of the Phoenixville machine that, within such limits as are now possible to determine, the gage readings may be accepted as reliably indicating the stresses which are applied, above the initial resistance of 12,000 lbs.

James E. Howard.

Watertown Arsenal, Watertown, Mass., April 22, 1909.

A LARGE CENTRIFUGAL PUMPING PLANT is being built for the new Alexandra Docks of the Newport Docks Co., at Newport, England. The plant will consist of two pumps, each direct-connected to a triple-expansion steam-engine, each unit having a maximum capacity of about 1,200 B. HP. In pumping water into the dock from the River Usk, the two pumps combined will handle 50,000,000 gals. in 5 hrs., or each unit will handle about 80,000 gals. per min., when running at 90 r. p. m. The same pumps are to serve subsequently in pumping out a graving dock (not yet built), and in this work will run at speeds up to 120 r. p. m., discharging 100,000 gals. per min. each, against a head of 42 ft. The pumps are being built by Willans & Robinson, of Rugby, and were designed by J. Orten-Boving & Co., of London. In planning this pumping plant, the question of electric driving or direct steam driving was investigated, and on account of the varying heads to be pumped against the steam driving was selected as most economical.

A COAL DUST EXPERIMENT GALLERY near Segengottes, Austria, is described in the "Iron and Coal Trades Review" of Sept. 10, 1909. Experiments are still in progress at this gallery under the auspices of the Vienna committee on fire damp with the object of determining conditions under which coal dust is likely to explode. The gallery, which is 964 ft. long, is constructed of masonry and is buried under from 6½ to 70 ft. of earth, the depth of earth covering decreasing as the distance from the explosion chamber increases. The explosion chamber is of concrete, 6 ft. high, 6½ ft. long and 4¼ ft. wide. The arched roof of the gallery is 6¾ ft. above the floor at the end nearest the chamber and its height increases to 7¾ ft. at the further end.

The gallery is equipped with sloping wooden ledges for coal dust and with apparatus used in investigations of the efficacy of preventive measures such as wet zones, water sprays, and zones of stone dust. The length of flame produced by the explosion is measured by means of sulphur matches placed along inside the gallery at intervals of 40 ins. Samples of the fumes produced by the explosion are obtained by means of loosely corked bottles of water suspended bottom up in the gallery 33 ft. from the explosion chamber. Strings attached to the corks are fastened to the nearest rack of shelves which are hung at intervals in the gallery to hold coal dust. The movement of the shelf racks due to the explosion draws the corks and the water runs from the bottles and is replaced by gas. The samples thus obtained are found to contain 0.8% to 6.45% carbon dioxide, 0.3% to 3.2% carbon monoxide and 10.95% to 18.8% oxygen.

A New Method of Grading and Draining Street Intersections.

By WM. W. MARR,* M. Am. Soc. C. E.

The grading and draining of street intersections raises many questions which seem to have been given less consideration than they really deserve.

Of course there are many cities where local conditions are of so varied a nature that no rule of construction could be followed with sufficient uniformity to make it practicable; but, on the other hand, there are numerous places where, like Chicago, a set form of construction could be advantageously followed in the great majority of cases. Though in Chicago the city is so nearly level that a grade in excess of 1% in paved streets is very rare, we have at least ten different methods of grading and draining our intersections. Of this number, two general forms cover all but the most exceptional cases. These forms are known as "inlet corners" and "summit corners."

Inlet corners are those where the sewer inlet comes at or near the curb corners and the drainage is toward the intersection. Summit corners are those where the summit (the high point of the gutter) comes at the curb corner and the drainage is away from the intersection. Each of these forms has advantages and disadvantages, and each has its champions, the honors being about equally divided.

The following are the arguments more commonly advanced for and against the two general forms of draining intersections: The inlet can be more readily found when stopped if it is located at the corner, than if it is at some distance from the corner. Intersections naturally receive special or extra attention, and the inlets at intersections are therefore less liable to become stopped than if located elsewhere. An inlet at an intersection which becomes stopped is such a nuisance as to demand and usually to receive immediate attention, whereas if it is in the middle of the block, it may be neglected for long periods and the water that collects allowed to stagnate.

If the summit is placed at the intersection, the intersection is the highest point in the street and the water must run from this high point, thus insuring (?) a dry crossing. If the summit is placed at the intersection the step from the sidewalk to the street is reduced to a minimum, and the very dangerous and objectionable false gutter is done away with. The breakage of the curb from expansion of cement walks is much less at summit than at inlet corners.

If there is no false gutter at an inlet corner, the step from the pavement to the sidewalk is usually so great as to constitute a nuisance, and in the event of the inlet becoming stopped, one must sometimes walk half way up the block to find a place to cross the street. If there is a false gutter or crosswalk step at an inlet corner it is a constant menace to man and beast, and defying all efforts to keep it clean, it becomes a catch-all for waste paper and rubbish of all sorts, an eyesore and an abomination. If the false gutter extends all around the corner, it makes a dangerous place for the wheels of vehicles to be caught in, and if it does not extend around the corner, the crown of the pavement at the corner is so great as to become in most cases dangerous.

When the summit is at the curb corner traffic "cutting the corner" will run over the shallow curb and break it. If an obstruction, such as street sweepings, a pile of building material, or a snow bank, happens in the gutter, and the summit is at the curb corner, the water being unable to drain off, will back up and submerge the crosswalk.

A form of construction which seems to have all the advantages of both the summit and inlet corner, and none of the disadvantages of either, is shown by Figs. 1 and 2. Here it will be seen that the curb is high enough to "curb" traffic, yet not high enough (or rather the gutter deep enough) to make the crown in the pavement objectionable. The step from the pavement to the sidewalk is done away with entirely, thus making the simplest form of crossing possible. The advantage to small children, to invalids and to women wheeling go-carts, of having no step at the crossing is very great. The false gutter, so dangerous, unsightly and unhealthy is also eliminated, and the danger of breakage from expansion is reduced to a minimum.

The thickness of the asphalt joint should be determined by the length of cement walk back of it, allowing .02-in. per lin. ft. of walk. This allowance is based on an average of several measurements taken by the author on walks about 300 ft. long which expanded about 6 ins. each. One end of one of these walks is shown in the view, Fig. 3. This walk never contracts to its original position, of course, and the greatest expansion occurred in the first warm season after being laid. In cases where the walk has been in place over a year the asphalt joint need not be so large.

There are two objections to this form of construction; the additional cost of inlet pipes and gratings and the difficulty of cleaning the long inlet pipe. In the first case it seems to the author that the benefits derived, the saving in damages, cost of cleaning and maintenance and the greater convenience to the public more than compensate for the extra outlay of money. In the second case the author has the support of a number of practical and experienced sewer builders in the belief that no trouble need be anticipated from the long inlet pipe if it is put in properly in the first place; that is, if it is given plenty of pitch, is laid in a straight line, is protected by an iron grating and so situated with respect to the summit that the water it is supposed to carry off will never, even in cases of

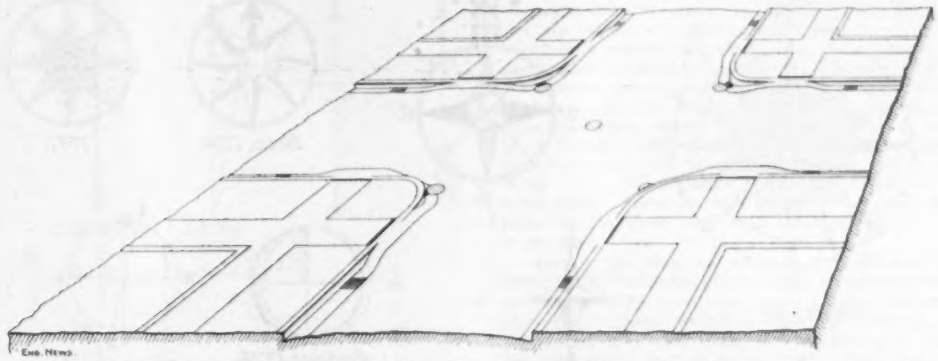


FIG. 1. PERSPECTIVE SKETCH OF METHOD OF DRAINING STREET INTERSECTIONS IN USE IN CHICAGO.

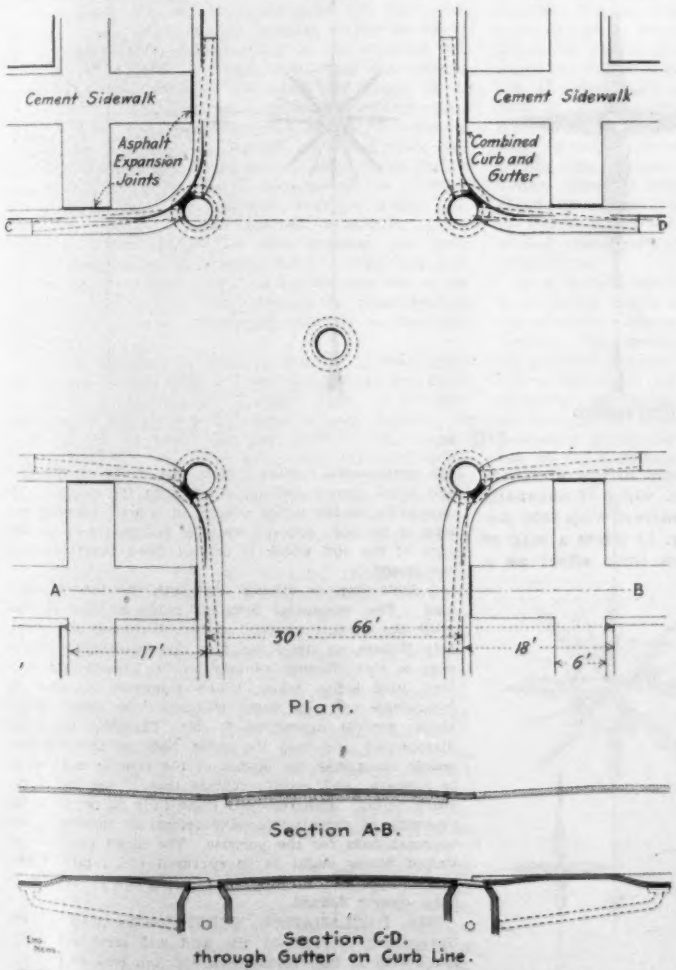


FIG. 2. PLAN AND SECTIONS OF A METHOD OF DRAINING STREET INTERSECTIONS AT CHICAGO.

Fig. 3. View Showing Expansion of Concrete Sidewalk at Hamlin Avenue and Congress Street, Chicago.

*Division Engineer, Board of Local Improvements, Chicago, Ill.

heavy storms, be great enough to rise above the top of curb when the inlet is stopped.

The drawings show a case where the catch basins are already at the curb corners. If the basins are located some distance from the corner, as is frequently the case, a still better form of construction can be had by simply building a new basin at each curb corner and doing away with the long inlet.

The author has built a number of these intersections this summer and they seem to meet with very general approval.

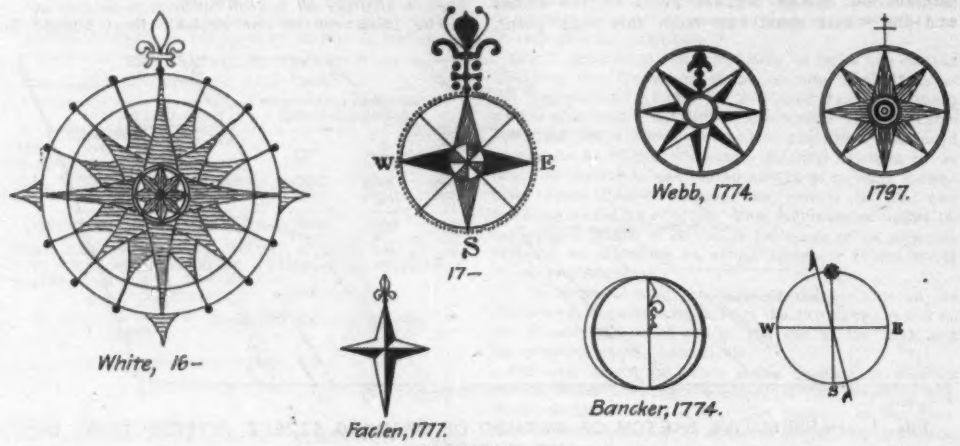


FIG. 1.

Direction Marks for Maps.

By A. W. BEDELL.*

Direction marks used on maps for showing the points of the compass are not usually given much thought; but many times a draftsman will have some difficulty in finding a design suitable as regards appearance, and at the same time easy to make. An otherwise well made map is often spoiled by an ill-chosen attempt of this kind. In the collection illustrated here many of the figures are worth remembering, while others are entirely impracticable, and are shown only on account of their age and oddity. They are mostly from maps of the vicinity of New York.

A good practice for the draftsman is to use the simplest ones (not the crudest); but when a map is large or very much filled up with details, they need to be somewhat more elaborate in order that they may have the required prominence. Freehand penwork increases the time and difficulty of the drawing, and as a rule is not very effective, while instrumental work is more quickly done and brings surer results. The one by Harrington (Fig. 2) is especially good, as, besides its neat appearance, it is composed almost entirely of parallel lines, and is remarkably easy to draw. In this connection it may be said that radial lines are very slow to draw, so that nobody whose time is of any value should attempt to do by hand a compass diagram like that which the U. S. Lake Survey has on its marine maps. However, like protractors, these may be useful in taking bearings directly off the map. On these the local declination is stated, and also the annual change, which is a very good way wherever both bearings are given.

Some of the best designs are those that consist of a straight line only with ornamental ends, like that of the U. S. C. & G. Survey. (Fig. 5.) These are sometimes drawn entirely through the map like a meridian. They indicate all that a person usually wants to know—the north; showing too many other points often obscures this one. In order to attract the eye towards the north, the arrow should increase in weight in this direction, like the one by Bicht (Fig. 5), which is unusually dynamic for a pointer. In contrast with this, notice the one by Bancker (Fig. 1) (from a map of Cortlandt Manor), which has little effect as a pointer, but is rare in its artistic lines. At the time when New York state was first laid out into patents and manors, some of the King's surveyors must have felt the lack of bench marks and base lines, and thought it a compensation to put plenty of compass marks on the maps; one of these had four or five placed wherever there was a vacancy.

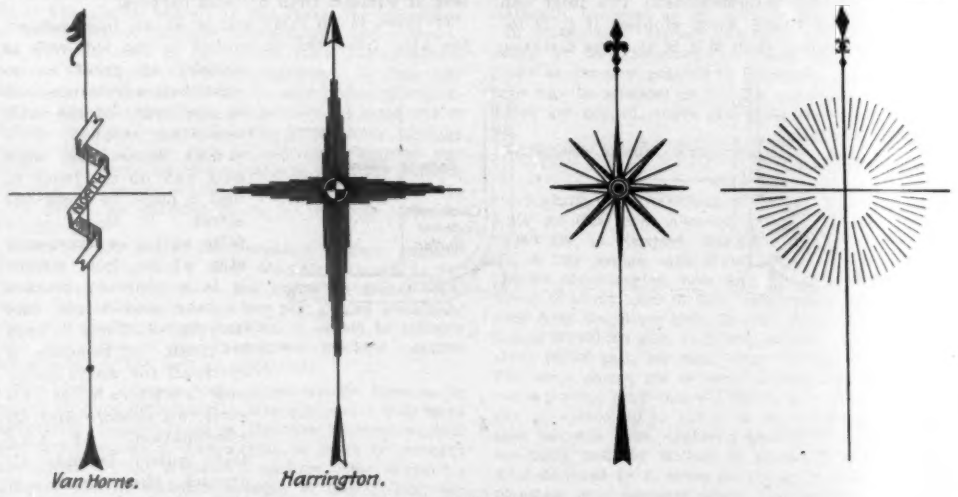


FIG. 2.

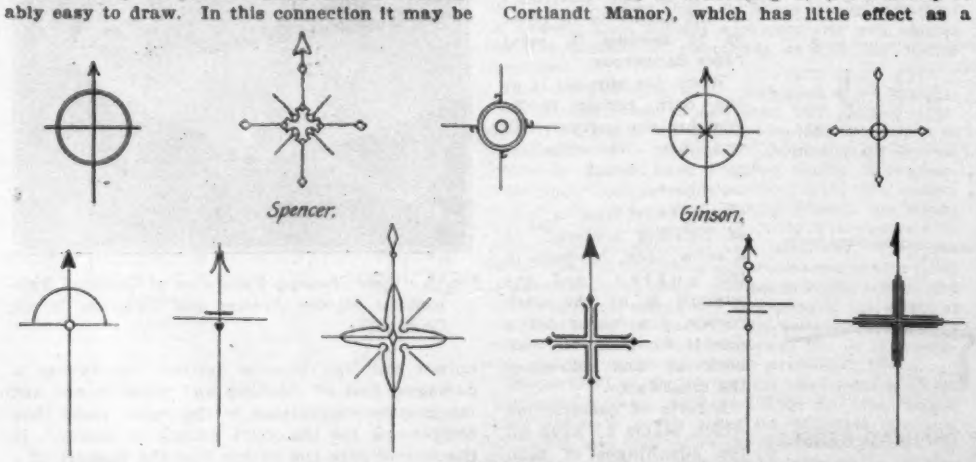


FIG. 3.

In looking over these diagrams it will be noticed that the oldest ones are reproductions of the compass dial, while the later ones are based upon the arrow. For engineering purposes the plainest shapes are best; and an important consideration nowadays is that they should be suitable for blue-printing.

*Chappaqua, N. Y.

President Taft on Conservation and the Work of the Reclamation Service.*

FOREST PRESERVATION.—The National forests, as reserved by executive order, contain about 167,000,000 acres of land in the United States proper. All of this land is now under the direct control of the Forestry Bureau, and is being preserved from fire and from other destruction, and is being treated in accordance with the best modern methods of treating forests under the supervision of Mr. Pinchot, the Chief Forester, and the head of the Bureau of Forestry in the Department of Agriculture.

It appears that the Government timber land is only about one-fourth the timber land owned by private individuals, and only 3% of timber land owned by private individuals is properly looked after, according to modern methods of forestry. The destruction by fire of forests is estimated to be $50,000,000 a year.

It would seem, therefore, imperative that the States should exercise their jurisdiction over these forests to which I have referred, and which are held by private individuals, and require some system of fire protection and the adoption of the best methods of forestry.

It would seem that the states have a right to do this because of the general interest which the public has in the preservation of the forests and in its equalizing of the water supply and its effect upon the climate. The regulation of the water supply, of course, prevents erosion of the soil, and the wasteful destruction of the best part of the soil which is carried down the rivers with the floods.

I don't stop to discuss at length the forestry question. The wonderful progress made by Mr. Pinchot, with the earnest support of Mr. Roosevelt and Secretary Wilson, at times has met the denunciation of persons in this Western country on the ground that property was being taken which Congress intended for individuals and was being withheld from them. But I think general opposition to Mr. Pinchot's plans has disappeared and that the great body of the American people recognizes the benefit of the reform in reference to forestry, and greatly regrets that it was not begun years before. Congress has come fully to recognize the necessity of pursuing forestry reform by making liberal appropriations for the purpose. The forest lands of the United States ought to be surveyed and carefully preserved, and the jurisdiction of Congress in respect to them clearly defined.

THE RECLAMATION SERVICE.—The plan of the Government to reclaim the arid and semi-arid lands, manifested in the Reclamation act, has been carried out most rapidly by the bureau charged with its execution. There are some 30 projects which have been entered upon by the Reclamation Bureau, and I believe that all of them are to be commended for their excellent adaptation to the purpose for which they were erected, and for the speed with which the work has been done.

It is believed, however, that in the planning of a number of these improvements, the enthusiasm of the projectors has carried them to a point where they begin

*From an address delivered at Spokane, Wash., Sept. 28.

to feel embarrassed in the matter of resources with which to complete the projects, and begin to show that prudence was not observed by those engaged in executing the Reclamation act; that the projects were too many and more than could be completed in a reasonable time after their beginning, because of a lack of funds.

I think there is no doubt that it was the intention of Congress that projects should not be multiplied in such

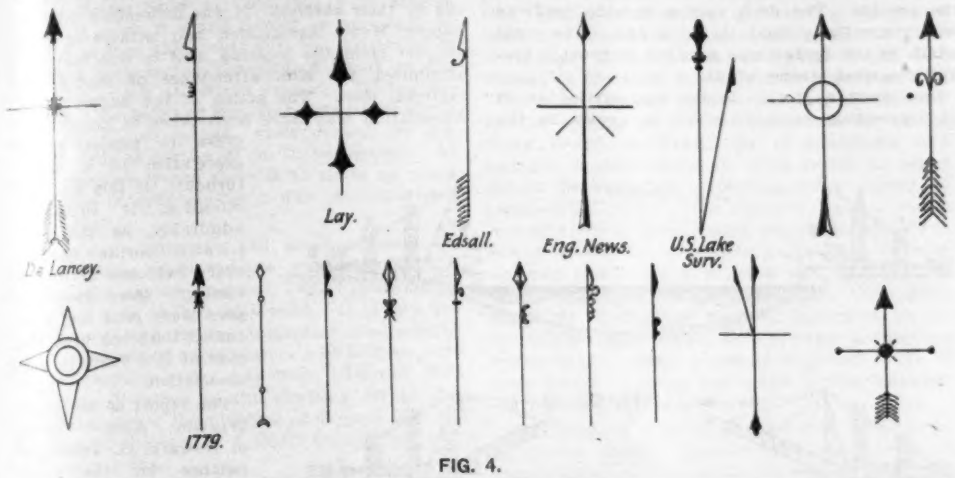


FIG. 4.

a way that they could not be completed within a reasonable time with the reclamation funds provided by the sale of public lands, and it probably would have been wiser to adhere strictly to the limitation thus construed, even though the language of the act, by dividing up the projects into parts on terms, seemed to permit the beginning of more projects than there was likely to be money enough to complete within a reasonable time.

The pressure was doubtless very great and the reclamation service yielded to the pressure within the letter of the law, and now finds itself in the situation described. The work has been well done and reflects credit upon the engineers who have had charge of it. But something must be done to relieve the present situation. I think it wise to apply to Congress for relief by urging the passage of an enabling act which shall permit the Secretary of the Interior to issue bonds in the sum of $10,000,000 or more to complete all the projects. These bonds should be redeemed from the money paid into the reclamation funds after the completion of the projects. From conversation with Senators who have visited much of the reclamation work, I infer that such appeal seems to them to be the easiest way out of the difficulty, and I shall take pleasure in recommending the passage of such a remedial measure by the next Congress.

Payment for irrigated lands is required in ten annual instalments. Suggestions are now being made that these should be lengthened into a longer term. I sincerely hope that Congress will not listen to such appeals. It may be well to make the first three or four instalments nominal, but after that time the instalments should be large enough to pay the total amount due, upon which no interest is calculated, in ten years. Another course will encourage lack of thrift and industry and greatly embarrass the extension and continuance of irrigation.

CONSERVATION OF THE PUBLIC INTEREST IN MINERAL LANDS AND WATER-POWER SITES.—When the government became possessed of its public domain and took measures to secure its settlement by the passage of the homestead act and other acts offering, after certain steps prescribed, to vest title to a specific part of the public lands in individuals the chief objects of Congress seemed to be to secure development by inducing people to settle on public lands and acquire it for themselves. The thought of conserving the resources which were thus opened to private acquisition hardly occurred to Congress. Its generosity to the Pacific railroads in offering the public lands in such extensive grants to them is an instance of the spirit which actuated Congress 40 and 50 years ago.

I am not criticising Congress in the slightest for this policy. It certainly was necessary to make extensive grants to secure the construction of a railroad which should unite the Pacific coast with the Atlantic coast and bring closer to the eastern seaboard the far-distant regions of this country. I merely refer to it in a historical way to explain the character of the statutes now upon the statute books with reference to the sale and disposition of public lands.

There has always been a distinction made between agricultural lands and mineral lands, because it was recognized that mineral lands would probably be much more valuable, and a different method was required for the acquisition of the one from that of the other. But never until now has adequate provision been made for a classification of lands so as to show distinctly what are mineral lands and what are agricultural lands. The truth is that the needs of the country have developed so, and the demand for land has so much increased, that in order to secure a sensible, business-like disposition of the lands remaining in the public domain there must be an authoritative classification of lands by the proper bureau, so as to show whether they are agricultural lands, forest lands, lands available for water power sites on the banks of streams, mineral lands, coal lands, oil lands or phosphate lands. Had this classification been made earlier it would have saved a great amount of litigation, and would have saved to the government millions of acres, patented as one kind of land when, in fact, it was another. The classification is being rapidly executed by the Geological Survey. After classification legislation should be, and doubtless will be, directed to the means by which such lands should be disposed of, and the restrictions specified in the interest of the public on the tenure and use to which the owner is to put such lands.

As to lands which are purely agricultural, there would seem to be no reason for departing from the ordinary method of disposition under the homestead and other laws, including the reclamation acts, by which citizens acquire title in them.

With respect to forest lands owned by the public, they should be surveyed and held by the Government under the regulation of the Forestry Bureau, permitting a sale of such timber as shall be necessary in the proper forest preservation.

As to water power sites, there has been such a change in conditions that a special provision should be made in the interest of the public for their transfer to private control. The development of electrical appliances and the transfer of power through electric lines for long distances has made the use of water power, to produce electricity, one of the most important sources of power we have in this country, and will so affect the cost of production in all the fields of manufacture and production of the necessities of life as to require the government to retain control over the use of such power by private capital when it can only be exercised upon sites which belong to the government. Such sites can be properly parted with under conditions of tenure and compensation, consistent on the one hand with reasonable profit to the private capital invested and, on the other, with the right of the public to secure the furnishing of such power at reasonable rates to every one. There should be a condition of forfeiture if the owner of the power site does not, within a certain time, expend capital sufficient to develop the power, and after development he shall not charge rates to the public beyond what is a reasonable profit on the capital invested in the improvement to be regulated by the government.

The amount of compensation that ought to be charged by the government for the use of the water power sites might perhaps be left to readjustment every 10 to 15 or 20 years. The compensation to be charged in the outset might well be purely nominal, but after the project has become a complete success and the profit has grown to a considerable percentage of the amount invested, then there would seem to be no reason why the public might not be benefited by sharing in the profits of the transaction to an amount to be fixed upon arbitration or in some other method at the end of a stated period of 15 or 20 years. This is an arrangement toward which the tenure of all public utilities is tending, and I know of no reason why it should not be introduced into the governmental disposition of such sources of continuous power as the water sites upon public lands are likely to be.

I know it has been the course in the past under the bounteous and generous disposition of the government to give these water sites away under existing inadequate acts; but we have reached a time now when the importance of these water power sites has greatly increased, and there would seem to be no reason why it would interfere with a speedy development of the country to impose restrictions upon the use of such water sites equitable as between the public and the investor. This is a matter which Congress must take up. The water power sites are now generally disposed of under the same kind of a procedure as that by which agricultural lands are taken up, and there is no power on the part of the Secretary of the Interior in the disposition of such sites to impose the conditions suggested.

The matter has become so important that under the last administration large tracts of land, amounting to upward of 4,000,000 acres, were temporarily withdrawn from settlement in order to prevent the acquisition of water-power sites under the general land laws. This amount has been reduced under the present administration to 450,000 acres. It should be understood that these withdrawals are temporary, and can be justified only as having been made in order to permit Congress to legislate on the subject of water-power sites. Should Congress conclude not to do so, it would be difficult for the Executive to find the authority indefinitely to withhold these lands from settlement under the general laws on the ground that they contain water-power sites. The legislative power is vested in Congress and not in the Executive.

I shall, therefore, urge upon Congress, at its next session the passage of a law authorizing the disposition of such water-power sites upon terms of the character already indicated, to be agreed upon by the Secretary of the Interior with the proposed purchaser. It may turn out that restrictions of this sort are so burdensome as to discourage the investment of capital, and it may be necessary to modify the requirements on this account. My impression is that the demand for water-power is going to be so great that these restrictions will not prevent the investment of capital, but will ultimately bring to the public coffers a revenue from an entirely proper source and will secure the development of a power for manufacturing industries that will probably in time exceed the utility and value of coal and become a substitute for it.

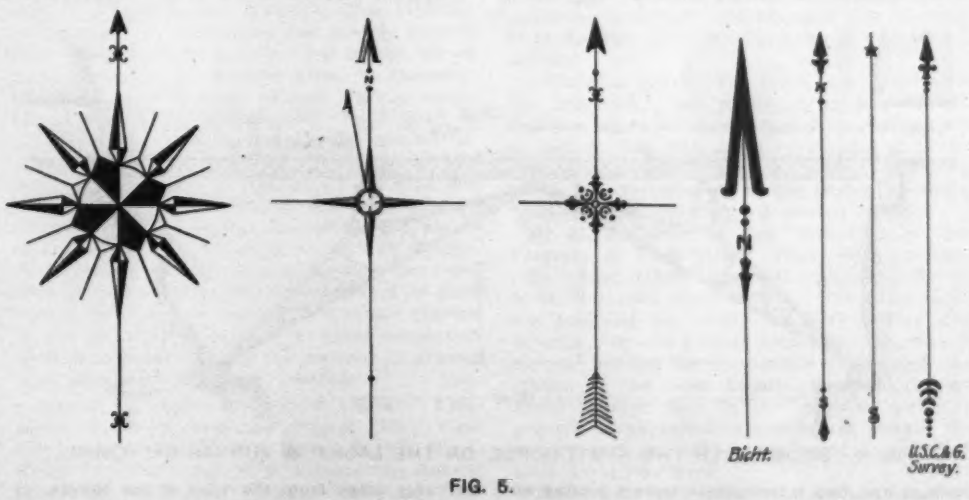


FIG. 5.

I now come to what should be the proper disposition of coal lands, oil lands, and phosphate lands. It seems wise in the disposition of coal lands, and indeed of all mineral lands having agricultural value, to separate the

surface of the land from its mineral contents, and then either to lease the right to take coal from the lands at a specified compensation per ton—that is, to provide a system of royalties—or to sell the deposits of the land outright to the coal miner. In every case, restriction by way of forfeiture ought to be included to prevent monopoly of ownership. This is the greatest object of a change in the method of their disposition.

The same provision should be made with reference to the disposition of the phosphate lands in Wyoming and Idaho, which contains the wonderful fertilizer which it will soon be necessary to use on much of the land in the United States.

The oil lands of California, as well as the phosphate lands and practically all the coal lands, have been withdrawn from settlement in order to await the action of Congress, and I expect to recommend to Congress legislation on the lines above indicated. What, however, I wish to make as plain as possible is that these purposes cannot be accomplished unless Congress shall act. The Executive can recommend, but the Legislature must enact.

There has been a good deal of discussion in the newspapers as to the attitude of the present Administration toward the general policy of the conservation of resources and some very unfair and altogether unfounded inferences have been drawn. The truth is that any Administration is pledged to follow out the policies of Mr. Roosevelt in this regard, and while that pledge does not involve me in any obligation to carry them out unless Congress gives full authority to do so, it does require that I take every step and exert every legitimate influence upon Congress to enact legislation which shall best subserve the purposes indicated.

I hope nothing will prevent our taking further steps needed when Congress meets.

Secretary Ballinger of the Interior Department, upon whom will fall the duty of executing the new provisions of the law, is in entire accord with me as to the necessity for promoting in every legitimate way the conservation of the resources which I have named, and he can be counted upon to use the great influence which he must have as Secretary of the Interior to this proper end.

Indeed, it will be found that in his reports as Commissioner of the General Land Office he brought these matters to the attention of Congress and urged the adoption of a Federal policy along the lines I have indicated.

Two Curious Bridges on the Indo-China Railways.

The French have built in their colony of Tonkin a railway from the port of Haiphong to the Chinese frontier at Laokai, 183 miles, and are extending it to the Chinese city of Yunnan, 290 miles further. This latter portion is expected to be completed in 1910. The lines are of meter gage, with some heavy works and large bridges.

In Fig. 1 is shown the bridge crossing the Namti gorge, 70 miles north of Laokai, and having an approach tunnel at each end. A two-hinged arch is formed by two pair of triangular trusses, whose heels have hinge bearings and whose heads are fitted to a center casting. These

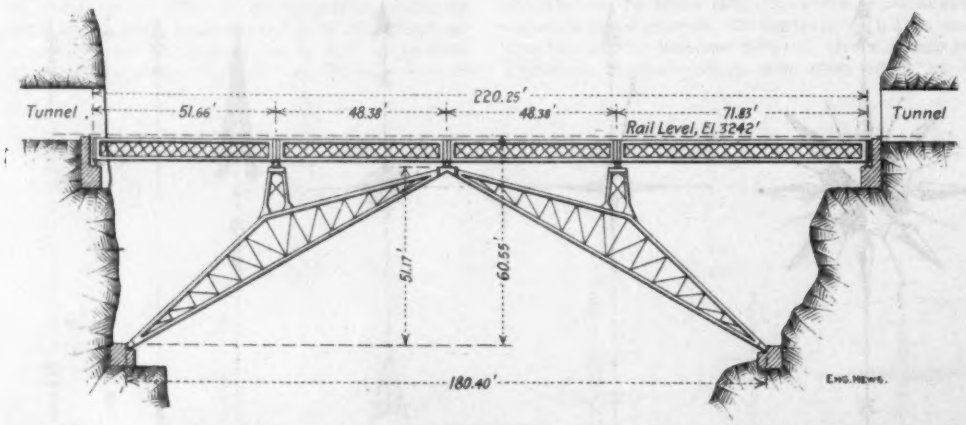


FIG. 1. BRIDGE OVER THE NAMTI GORGE, ON THE LAOKAI & YUNNAN RY. (CHINA).

castings and two intermediate towers resting on the trusses carry the bearings for the four lattice-truss spans. The span is 180.4 ft. and the rise 51.17 ft. This is on the part of the line ascending to the Yunnan plateau, which is a continuation of the Thibetan mountain range. The range will eventually be crossed by an extension of the Burma Railways, opening railway communication between India and China.

From Hanoi, on the Haipong & Laokai line, a railway extends south to Vinh, 208 miles. This crosses the Song-Ma River by a three-hinge arch bridge having the roadway suspended from the arch trusses, as shown in Fig. 2. This has a span of 532 ft., and a rise of 82 ft. from the rails to the crown pin of the center hinge. The trusses are spaced 33 ft. c. to c., and the end bents form the portals. The deck carries a wide roadway with the railway track in the middle. The great width of the bridge was adopted to provide stability against strong winds.

The erection of this bridge was carried on in an interesting method, which is shown in the

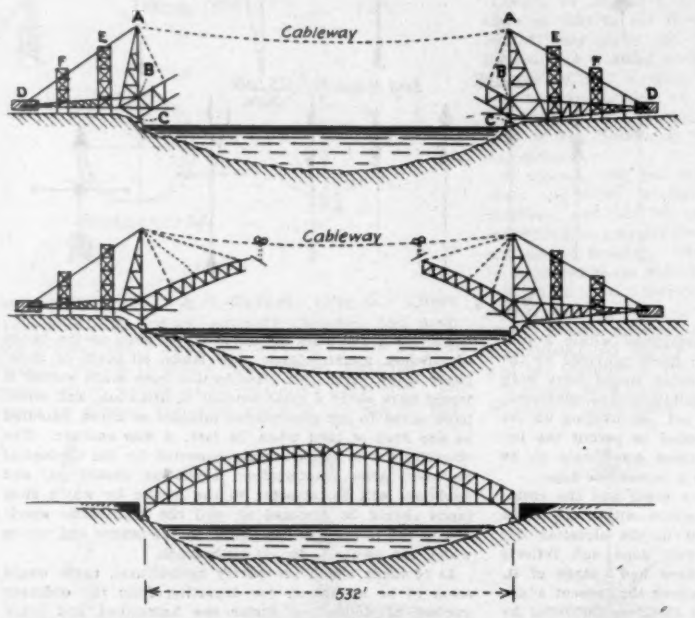


FIG. 2. BRIDGE OVER THE SONG-MA RIVER, ON THE HANOI & VINH RY. (TONKIN).

cut. The portal bents (B-C) were first set in place upon the piers and to these were attached temporary L-shaped structures (A-B-C-D), the upright arm forming a tower and the horizontal arm forming a balance lever fitted with a counterweight box. These structures were of combination wood and steel construction. The ends (A) (D) were connected by rigid steel ties, supported by the wooden towers (E) and (F) which were used in their erection. The main or rocking towers were connected by a cableway with two trolleys for setting the members in place, the uncompleted portions of the arch being supported by cable stays from the tops of the towers, as shown. The adjustment for the central connection was made easily by means of the balanced rocking towers. The weight of the bridge is about 1,200 tons.

The above particulars are taken from a long paper on "The Railways of Indo-China" by Mr. R. Godfernaux, published in the "Revue Generale des Chemins de Fer."

Annual Convention of the Central States Water Works Association.

The 13th annual convention of the Central States Water Works Association was held at Columbus, O., Sept. 28 to 30. There was a little more than average attendance of Active Members, but the Associate Members were conspicuous by their absence. It was understood that the Supply Men's Association had withdrawn their support from the meeting, and to this fact was attributed the slim attendance of supply and material men. The action of the Supply Men's Association may have been taken in kindness in order to stimulate the association to a better turnout. If this was the intention, it succeeded admirably, as the supposed corpse showed every evidence of active vitality. More good papers were read and discussed than has been the case of late years in this association.

The report of Secretary William Allen Veach, of Newark, O., showed a balance on the right side of the ledger. Mr. Veach stated that the field of the association is more especially with the smaller plants throughout the populous states embracing its territory, whose owners and operators can attend the conventions with less expense than they can the conventions of a purely national body.

Mr. Alba L. Holmes, M. E., Grand Rapids, Mich., who was later at this meeting elected Vice-President of the association, read a paper entitled "Some Random Suggestions from a Water Works Engineer," in which he championed the use of water meters, and condemned in unmeasured terms the practice of blindly copying schedule of rates from those in use in other places without first thoroughly analyzing local conditions and adjusting the rates to them. Mr. Holmes' paper contained some side remarks as to introducing sales of water motors and stimulating the more general introduction of sanitary conveniences, as well as the encouraging of street sprinkling. The paper elicited a very general discussion.

Mr. J. D. Berg, M. E., contributed a paper on "The Development and Use of Centrifugal Pumps," among the advantages of which he enumerated are smaller initial cost of installation than in other pumping machinery which is capable of the same economy; absence of large size packing; less frequent packing necessary; small cost of lubrication; small cost of repair parts; minimum cost for attendance and repairs. Compound pumps have made it possible to obtain any pressure with a centrifugal pump that can be obtained with other types, and do it efficiently. It is possible to get any characteristic which is desired, and the centrifugal pump has been so developed that it can be determined with exactness what capacity will be discharged at varying heads, and it can be definitely guaranteed that the driving apparatus will not be overloaded, regardless whether the discharge head is increased or decreased. Bronze instead of cast-iron impellers are now used, and all points at which there is a possibility of wearing are protected by small removable parts, which makes the up-keep small.

The writer referred to various installments where centrifugal pumps are giving excellent service economic and industrial plants. One field where motor-driven centrifugal pumps have been used to good advantage in water-works for towns is that of Booster service for outlying districts.

Mr. S. Bent Russell, M. Am. Soc. C. E., St. Louis, Mo., read a paper on the cost of clearing water in settling basins. This was considered a valuable contribution to the literature of the subject.

On the first day, the delegates and visitors were taken in a special car to the Columbus sewage disposal plant.

If the Scioto River at Columbus were always at normal stage, it would hardly be necessary to give the sewage any treatment, but treatment is necessary because the quantity of water in the river falls so low at certain seasons. During the spring the discharge of the river runs up to about 30,000 cu. ft. per second, while during the dry spells it falls as low as 50 cu. ft. per second. At the purification works there is at times as much as 10 tons of solid matter a day removed from the sewage.

The sewage pumpage has averaged only 9,800,000 gallons daily for the month of August, considerably below normal, the intercepting sewer has been choked with sand. It is now being cleaned, and in the meantime the outflow from a number of cross sewers which drain into this intercepting sewer has been diverted into the river. Previous to the shutting off of this interceptor sewer the filtering of sewage was being done at the rate of 4,500,00 gallons per acre of filters per day.

The quality of the effluent is determined by the putrescibility. It is expected to be after treatment non-putrescible. To test this, a sample is kept at blood heat temperature for 40 hours. If it does not show any offensive odor it is non-putrescible. In the month of August, on one day, this test indicated that the effluent was putrescible; on one day it was not determinable; during the remaining days it was non-putrescible.

At the Wednesday night session a paper was read by Mr. F. P. Leopold, of the Pittsburg Mfg. Co., Pittsburg, Pa., entitled "The New Filtration Plant for Wilkinsburg, Pa.

Dr. A. G. Sandblad, Chemist and Bacteriologist of the McKeesport, Pa., water softening and filtration plant, read a paper on the timely topic: "Is Softened Water a Desirable Municipal Supply?" Writers on hygiene pronounce as an ideal of an exceptionally good drinking water one which while conforming to other standards of purity does not contain more than 20 grains of mineral matter in solution per the Imperial gallon; in other words, 28.57 parts per 100,000. The weekly analyses at McKeesport show that their softened water contains very much less than this proportion, and it therefore constitutes a very desirable municipal water supply, while affording manifest advantages in the saving of soap, preventing damage to clothes in the laundry, better results in cooking, and a great diminution in the albuminoid ammonia in the filtered and treated water, which at times amounts to a total disappearance of albuminoid ammonia. All of the bacteria disappear in the process of settling.

The following resolutions were offered by Mr. C. W. Wiles, Delaware, O., and were adopted unanimously:

Whereas, The establishment of Public Utility Commissions in the states of New York and Wisconsin has been found beneficial to the public in insuring efficiency of service for water, gas, electric and other public supplies, and is performing a necessary work for the conservation of industrial effort; and

Whereas, This Central States Water Works Association is composed of representatives of both privately owned and municipal water-works having as a common object the furnishing of a sufficient and potable supply of water for consumption and for the protection of property from fire in the various communities in its territory, to do which fair and equitable rates must be charged to maintain the quality of the service; and as the public utility commissions where they have been tried have operated to the benefit of all classes of the community, and with justice to all; therefore,

Be it resolved, That this Association commend to the legislatures of Ohio and all other states within its territory, statutory enactment establishing like Commissions; and further,

Resolved, That a standing committee be named by the President of the Central States Water Works Association to inquire into the workings of the Public Utility Commissions where established with a view to still further perfecting the plan of same if possible and suggesting such legislation as may make them effective in all states where not now existing within our territory.

Mr. Paul Hansen, Assoc. Mem. Am. Soc. M. E., Acting Chief Engineer of the Ohio State Board of Health, Columbus, O., read a paper on "State Control of Public Water Supplies," in which he maintained that the state should have authority over such governmental functions relative to the municipalities as have an inter-municipal bearing and which in their nature cannot be fully controlled by the municipalities themselves. He embraced under these among other matters, the purity of streams and dairy supplies. He held that mal-administration of city governments leads to state control; but even though the cities were more efficiently governed there would still remain to the state boards an advisory function.

The Ohio law at present provides no penalty for non-conformity with the requirements of the State Board of Health as to conditions and changes in water supplies. This defect he urged should be remedied, especially with regard to purification plants. He referred to the Bense Act of April 7, 1908, which authorizes the State Board of Health to require purification of sewage and public water supplies and protection of the streams against pollution. The Ohio State Board of Health has recently instituted an investigation into water and sewage purification works in the state, which is expected to be of great practical value, but which is now languishing because of lack of funds.

On Thursday morning a paper was read by Mr. C. Arthur Brown, Sanitary Engineer, American Steel and Wire Co., Lorain, O., who presented an elaborate paper which he modestly entitled, "Suggestions on the Use of the Iron and Lime Process of Water Purification."

Mr. A. M. Fisher, Superintendent and City Engineer, Coshocton, O., described the filtration well at Coshocton, O.

In the "Question Box" the following inquiry was propounded:

What arrangement have members for keeping an accurate account of motor washing machines when a flat rate is in use and where the seller of such machine refuses to give the water department a list of purchasers?

Mr. A. W. Inman said that he made an experiment in his own home, his family consisting of 5 or 6 persons. He found that the amount of water consumed by the motor would amount to $9 and $10 a year at the 25-ct. rate. If a flat rate is in use considerable wastage of water may be expected, as the motor is often allowed to run unnecessarily. He believed that a properly regulated machine with economy in use ought not to consume over $5 worth of water a year at the 25-ct. rate.

Mr. M. Hetzer, Moundsville, W. Va., reported that they had about 40 washing machine motors in use and had made a flat rate on them of $9 a year, with the option of putting on a meter at 50 cts. a thousand. A few have put on meters but report that they find it cheaper under the flat rate.

Mr. C. Arthur Brown, of Lorain, Ohio, reported several cases of electrolysis and showed lantern slides illustrating them. One was a 6-in. water main containing some holes 4 ins. in diameter. The pipes affected were located directly under the crossing of an electric line. In a plant in northern Ohio the injury developed about 300 ft. from any apparent source of electricity. It was found that this was caused by an old pipe line which had been disconnected and was lying in the ground and carrying the electric current in close proximity to the water mains. At Oberlin, Ohio, a large number of lead services were destroyed, and the trouble was attributed to electrolysis until it was discovered that the gypsum in the soil seemed to have a direct connection with the trouble. When the pockets of gypsum were eliminated the trouble ceased.

Election of officers resulted as follows: President, T. H. Verner, McKeesport, Pa.; Vice-President, Alba L. Holmes, Grand Rapids, Mich.; State Vice-Presidents, F. J. Brinkoetter, Quincy, Ill.; Thos. McNamee, Wabash, Ind.; Asa Williams, Owensboro, Ky.; W. A. Clark, Wyoming, Ohio; W. J. Scroggins, Wheeling, W. Va.; H. C. Lee, Sharpsburg, Penn.; S. B. Russell, St. Louis, Mo.; and Fred Bosch, Whitewater, Wis.; Secretary, W. A. Veach, Newark, Ohio; Treasurer, A. W. Inman, Massillon. Indianapolis was selected as the place for the 1910 meeting.

Annual Convention of the Illuminating Engineering Society.

The third annual convention of the Illuminating Engineering Society was held at the Engineering Societies Building in New York City, Sept. 27, 28, and 29. The coincidence of the convention with the Hudson-Fulton celebration was intentional and followed the plans of holding the two previous meetings in Boston and Philadelphia. The growth and activity of this society have shown the widespread interest awakened in improved artificial lighting while the directness and practicality of most of the papers presented at this meeting indicate comparatively easy roads of progress now open. The total registration was 244 members and 185 guests.

The presidential address of Mr. W. H. Gartley, of Philadelphia, was on the physical and physiological processes of seeing. The address was presented in manuscript for the society proceedings and the author proceeded to talk about the society's growth.

A report of the committee on nomenclature and standards was presented in two sub-reports describing the steady progress of universal adoption of the international standard of candle-power (1.6% less than the former U. S. standard). France, England and the United States have adopted this unit and Germany has recognized the ratio of 0.9 to 1.0 as holding between its Hefner lamp and the new candle. The discussion of the reports turned on what terms it was most advisable to express illumination, some preferring total flux-area relations and others candle power-distance.

The presentation of papers was continued through four sessions, exclusive of a lecture, on one evening, by Dr. C. P. Steinmetz. In general, the papers were of the nature of investigation reports though a few notable exceptions lightened the program.

Prominent among this minority, was a paper, "The Ethics of Illuminating Engineering," by Mr. E. L. Elliott, of New York City, Editor of the "Illuminating Engineer." The paper was largely made up of meditations on what consulting engineers generally should not do. The point most emphasized was that a consulting engineer accepting a retainer from a manufacturing concern, for instance, could not honestly advise other clients concerning work that involved apparatus other than the perhaps limited line of that concern. This view, rather dogmatically expressed, naturally was mildly objected to in the discussion.

Mr. F. K. Richtmyer, of Cornell University, in "Illuminating Engineering from the Educational Standpoint," held that illuminating engineering was a specialty which could not be adequately covered by courses in an already crowded undergraduate curriculum. He proposed a brief study of photometry as a fair basis for post graduate activity.

A historical paper, "The Work of Dr. Carl Auer von Welsbach," was presented by Mr. Geo. S. Barrows. Here the importance of Dr. Auer's work on gas mantles was again reviewed and claims were put forward for him as the successful pioneer in the development of the modern metallic-filament lamp, through his osmian lamp.

Mr. H. T. Owens, of New York City, in "The Progress of Illuminating Engineering in Europe," very briefly ran over present conditions in the principal cities abroad. The street lighting generally was found far more intense with exterior lamps in greater profusion than here. In interior lighting the competition of gas and electricity, in the most artistic installation, was found greater than in this country, owing to greater advancement in gas-fixture design. Intensely brilliant lights were found as carelessly used abroad as here.

There were two papers on modern illuminating-engineering laboratories. The first of these was by Mr. C. O. Bond of Philadelphia, on the "Photometrical Laboratory of the United Gas Improvement Co.," for the testing of gas and gas lamps. The building, of two stories and basement, is about 26 × 100 ft. and houses a fine equipment for the study of both gas and electric

lighting. It is located at the Point Breeze Gas Works, in Philadelphia, and, on account of the location, the doors and windows are double-sashed and made as tight as possible. Air entering the building is filtered and has its humidity controlled.

Dr. E. P. Hyde, who left the U. S. Bureau of Standards to become director of a physical laboratory to be built up by the National Electric Lamp Association—an association of some 20 makers of electric incandescent lamps, detailed the objects of that movement. The purpose was announced as that of developing a pure-science rather than an applied-art institution. The organization has proceeded with a view to handling all problems and all studies in three classes; (1) those on the production of luminous energy; (2) those on its utilization, and, (3) the coincident effects of luminous and attendant radiation. The personnel includes physiologists as well as phyicists.

"Diffusing Mediums" was the title covering a collection of miscellaneous comments by Mr. A. J. Marshall of New York City, on globes used to soften the light from sources of too great intrinsic brilliancy. The good old ground glass was scored on what the author maintained were "esthetic grounds" because when viewed lighted they did possess an absolutely uniform light-shedding surface. The only thing to do is to use real opal glass.

"The Principles of Shades and Reflectors," by Dr. Louis Bell, of Boston, was a review of the effect of glass and other attachments of lamps in softening or redirecting the rays. Ground glass globes, surrounding lamps, were described as but slightly changing the distribution of light, merely reducing the glare. On account of the tendency of the iris of the eye to contract in the presence of a brilliant light, the gain in vision is much greater, with a diffusing globe, than is the loss due to the absorption of the glass. Of all shades, the simple flat plate was shown to be of the least use as it redirected rays included in an angle above the lamp where the light flux of the common electric lamp was normally least. The beneficial action of many others was very briefly touched upon.

"Standard Relations of Light Distribution," was the title of a flowery presentation of a scheme for making a series of curves for the light distribution from a lamp, or group of lamps, to secure uniform lighting over a few classes of interiors. If a man, with only a practical training and small working knowledge, should come up against a problem of this sort all he would have to do would be to buy fixtures, the distribution curves of which were close to such ones of the proposed curves as he would be told best fitted his problem. As far as this man was concerned it would be a blind and wholly empirical operation, but one needed to improve the illumination in the millions of homes and minor edifices where an illuminating engineer would never penetrate.

In "Operating Efficiencies of Commercial Installations," Mr. A. L. Eustice, of Pittsburg, briefly recounted results of some 18 months of work to compare the efficiency of lighting fixtures in commerical use with similar ones in the laboratory. Some 66 studies were reported on arc, carbon and tungsten-filament and Nernst lamps in various mercantile houses. The most remarkable figures were on the loss of efficiency due to dirty fixtures, this amounting to some 25% with arcs. With tungsten the prevalent drop was in the neighborhood of 10%, but ran as high as 33%. With the Nernst lamp the drop was notably smaller, varying from 1.5 to 4% usually. The published illumination figures of certain figures and combinations of lamps and reflectors were found to differ very substantially from the values found for samples found installed, on account of the influence of surroundings even where the effects of dirt and depreciation had been eliminated.

In "Factory Lighting" Mr. L. B. Marks, of New York City, reported the results of a few investigations into the lighting of factories with typical prevailing conditions. The data, presented in detail, showed almost entire absence of a general illumination after sundown and complete reliance on small spots, of high intensity, from lamps hung above the work. The amount of light needed on the work under these conditions was found to be ten to twenty times that necessary under general illumination. Many present installations caused a bad direct reflection from the work into the workmen's eyes, which made added illumination necessary to distinguish details and constantly weakened the men's sight.

"Tests of A. Moore Tube," by Messrs. C. H. Sharp and P. S. Millar, of New York, recited the results of a study of a Moore luminous tube, containing nitrogen, 176 ft. long, encircling one of the smaller assembly rooms of the United Engineering Societies Building in New York City. In brief, it was found that the tube, as operated, had an equivalent of about 8 c. p. per ft. and used 2.5 watts of energy per equivalent of mean spherical candle power. The power factor was 73%. It was found that the light went out, or nearly so, at each reversal of the alternating current, and this caused the strong stroboscopic effects noted. By running two tubes on currents 90° apart in phase, so that the maximum light from one tube overlapped the minimum from the other, the effect was nearly prevented.

Results of tests on a similar tube in the New York Post Office were reported in a paper by Dr. E. P. Hyde, of Cleveland, Ohio, and Mr. J. E. Woodwell, of New York City. This paper was read by title only and showed results very similar to the preceding study.

In the discussion on the Moore tube, Dr. H. E. Ives, of Washington, D. C., reported a new study, made with the colorimeter, on the color of Moore tubes containing carbon dioxide gas. (This instrument is for measuring light of any color in terms of a certain red, green and blue. It was briefly described in Engineering News, Oct. 15, 1908, p. 406.)

Mr. P. S. Millar, of New York City, in a paper entitled "The Problem of Heterochromatic Photometers," showed, by results of experimental studies, the difficulty of accurately determining the candlepower of a source, the color of which was even a little different from that of standard sources of known power. There were three physiological effects interfering: (1) the different sensitiveness of different eyes to colors, (2) the presence of a small spot on the retina, embracing a central visual angle of some 8°, more sensitive to red and yellow rays and less sensitive to green and blue than the rest of the retina, (3) the variation of the sensibility of the eye to different colors with varying intensity of illumination.

In the discussion of this paper, Dr. C. P. Steinmetz, of Schenectady, held that the only logical way of comparing light sources of different colors was by comparing their lighting effect. This was best done by the comparison of distances at which certain reading could be done under each light. For this method great accuracy was claimed possible. The meeting recommended that the council of the society take up the matter, to formulate methods of heterochromatic photometry.

The paper "Allowable Amplitudes and Frequencies of Voltage Fluctuations in Electric Lamps," by Dr. H. E. Ives, of Washington, was the reply of the U. S. Bureau of Standards to a question from a large manufacturing concern. Direct current of variable voltage was impressed on a source of alternating current of variable voltage and frequency. Starting with alternating current alone and increasing the direct-current voltage as the alternating was decreased, it was found that to prevent flickering it was necessary to increase the frequency from about 30 cycles per second up to 60. At this critical point a maximum was reached, and from here the necessary frequency decreased with an increasing proportion of direct-current voltage. At the critical point of maximum frequency, the maximum value of the alternating voltage equalled the direct voltage also impressed.

Dr. Angelo Simonini, formerly in Baron Welsbach's laboratory near Vienna, presented "Notes on Chemical Luminescence of Rare Earths," this being the account of experiments carried on there some 15 years ago. These were made mostly with a view of showing that the incandescence of the Welsbach mantle was due to alternate oxidation and reduction of the cerium and thorium oxides—changes from a lower to a higher oxide and back again. The most of the experiments, in one way or another, consisted of passing a mixture of illuminating gas and air over certain mixtures of the oxides kept at a gentle heat. The materials were made to glow as if held in a Bunsen flame, but each experiment was ended by an explosion of the gas-air mixture as incandescence progressed.

"The Light of the Firefly," by Messrs H. E. Ives and W. W. Coblentz, of the U. S. Bureau of Standards, Washington, D. C., showed the first comprehensive study of these insects since the famous work of Langley some 20 years ago. The insects used were the common species found in Washington. The spectrum of the light was photographed on plates sensitive to the whole visible spectrum and was found to consist of an unsymmetrical area in the yellow green. By spectrophotometric methods, recently made available, comparison with a carbon-filament lamp showed luminous efficiency of the firefly's lamp as 96.5%. Only 3.5% of the radiant energy was non-luminous.

The lecture of Dr. C. P. Steinmetz, of Schenectady, N. Y., was on the "Physiological Effects of Radiation." The subject was narrowed beyond the title and the harmful effects of light, and attendant radiations, on the eye were the topics discussed mainly. It was claimed that most eye trouble was not due to the artificial light itself but to the lengthened period of severe use now made possible. Where trouble was actually due to the light itself, two types of effects were noted. The first of these was termed "power burn"—meaning the effect of receiving too much radiant energy in the eye as by seeing a short-circuit flash or looking too long at a bright source, such as the hearth of a furnace. In this class of troubles the symptoms of trouble (blindness and inflammation) were immediate and acute, but recovery was rapid and eventually complete.

The second type of trouble was found less prevalent than the first—the effect of ultra-violet rays, such as sent out by open arcs or by spark discharges. In these "ultra-violet burns" the effects were not noted for several days, and the symptoms increased for a while after appearance. Recovery was very slow and usually not complete in several years. The first signs were headache, in the optical regions, followed by blurring of the sight and even by blindness. Most screens shut off the ultra-violet rays, even those glasses transparent to light. The exception described was quartz. It was found necessary to do more than to interpose a flat screen between the eye and the source, on account of the rays reflected about by the walls.

The speaker branched out, toward the end of his lecture, on the general effects of radiant energy on plant and animal life. He described the action of the chlorophyl of plants in absorbing the red and yellow rays of sunlight, acting on the absorbed carbon dioxide and storing the energy by the synthesis of various organic compounds. The life of animals was contrasted as a destructive process—one of combustion, using the compounds built up by the plants. The effect of light and radiant energy on high animal life was at first stimulating and later, if long continued at high intensities, destructive. High and low forms of animal life, by evolution, acquired protection from the effects of light and, once acclimated, did not thrive in darkness. Low forms of life, not used to light, were killed by sudden introduction into it. Thus pathogenic germs in the body were killed by light when brought near enough the surface. Treatment of disease by light was possible in cases where ordinary light could naturally reach the germs, and some progress even had been made with the use of rays that penetrated the body. With these, trouble had been encountered as the interior cells of the body were hardly less resistant to the rays than were the germs themselves.

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We print on another page of this issue the substance of President Taft's address on conservation, delivered at Spokane last week. It is of much interest as an authoritative expression concerning the policy of the Administration upon a matter which has taken a strong hold upon the popular mind. What the President has to say regarding the Reclamation Service is of particular interest. Those who have followed closely the work of that Service from its inception will give hearty approval to the President's recommendation for the supplementing of the Reclamation fund by a government bond issue, to be repaid from the revenue resulting when the settlers under the several projects pay for their land.

It is greatly to be regretted, however, that in his remarks upon the reclamation work, the President, probably through misinformation, gives a wrong impression to the public as to the reasons why such a bond issue is advisable. President Taft suggests that it would have been wiser if a smaller number of projects had been undertaken by the Reclamation Service, and that those in charge of it are to some extent blamable for permitting the beginning of more projects than there is likely to be money enough to "complete" within a reasonable time. Study of the Reclamation law, however, shows that the Service was obliged to undertake a very considerable number of projects, in order to distribute the work among the several states in accordance with the requirements named in the act.

Further than this, however, it is by no means clear that the rapid "completion" of a project would be desirable, or that it would be necessarily good business policy. A project is not "completed" until all the water that can be stored in the reservoir is utilized in distributing canals; but the reservoir must be built, in the first place, and it is better to build the canals as they are needed by increasing population, than to invest money in channels to supply farms for which settlers are not yet available.

According to our information, the work on a number of projects of the Reclamation Service has proceeded quite as fast as settlers have come in to take up the improved lands. If Congress consents to the proposed bond issue, its chief usefulness, we should suppose, will be rather to enable the undertaking of work which has been stopped by reason of Secretary Ballinger's ruling forbidding cooperative work between the settlers and the Government in the construction of canals. In the absence of specific facts and figures, therefore, we do not believe the President's statement, that "prudence was not observed by those engaged in executing the reclamation act," is at all justified.

Concerning the President's remarks on conservation of the public's interest in mineral lands and water-powers, we may comment at length in a future issue. At present it is gratifying to know that the President is emphatically in favor of protecting the public rights, so far as the executive has power. There can be no question, however, that the responsibility is laid upon Congress, and, more than that, upon the legislatures of the several states, to see that the principles of Conservation are embodied in law. It is probably true that those who stand for the public interest are likely at the present time to receive more "cold shoulders" than "glad hands" in the halls of legislation, national or state; but when our lawmakers awake to the hold which Conservation has on the popular mind, there may be a change in this respect.

In the current discussion regarding the public's right in undeveloped water-powers which still remain in state or national control, the idea is being strongly urged that such water-powers are worth very little. Annual rentals of a dollar or two a year, or even a few cents, are suggested as fair valuation. There is doubtless something to be said for such low values under present conditions of supply and demand for water-power in regions remote from large cities or large industries. The public, however, has some excuse for believing in the high value, present and future, of water-power. The public has found by bitter experience that whenever a water-power is turned over to private ownership, and at some future date it becomes necessary for the public to obtain possession of it, that which was once counted of little worth has become very costly to purchase.

In the State of New York an important series of suits is pending against the State, in the shape of claims for water-power damages growing out of the construction of the new barge canal. One of these suits, just decided on Sept. 30 in the New York Court of Claims, was that of the Fulton Light, Heat & Power Co. of Oswego County, New York. This company made a claim of $3,428,000 for damages to its water-power through diversion of water for use in the new barge canal. The State opposed the claim, on the ground that the original title to water-powers was vested in the State, and that the State was not liable to private owners of water-powers for the diversion of water from the streams for State uses. The Court of Claims, however, decided against the State on this point, and a final award of damages to the plaintiffs was made of $299,000. The case will be carried to the Court of Appeals before final decision is reached, but it is stated that if the right is established of private water-power owners to collect from the State because of the diversion of water from the streams for barge canal uses, the burden upon the State treasury will be very heavy.

Of course this matter of exorbitant damages claimed by owners of water-power condemned for public use is one with which engineers engaged in the work of city water-supply have long been familiar. It is the rule, rather than the exception, when a city has to establish or enlarge its water-supply by diverting water from running streams, that excessive damages have to be paid to the owners of water-power privileges. In the State of New York, a bad matter is made worse by the fact that the condemnation process is so carried on as to involve enormous legal expenses in addition to the actual sums paid in damages.

There seems to be no remedy for this mulcting of the public in huge sums by private owners of water-powers under our present governmental organization; but the experience ought to teach wisdom to our state legislatures and to Congress, with respect to the treatment of water-powers which are still under public ownership or control. Whatever else may be done or may not be done, it is certainly clear that in turning these water-powers over to private ownership for development, the right should be reserved to their reacquirement at some future time, in case of necessity, without the payment of the exorbitant and unreasonable damages for which the public is now held up.

The State of Maine has taken a forward step in the direction of water conservation, by organizing a State Water Storage Commission, under authority of a law passed at the last session of the Legislature. The members of the Commission are Messrs. Edward P. Ricker, of Poland, James M. McNulty, of Bangor, and E. C. Jordan, of Portland, with the Governor of the State ex-officio. The Commission is to collect information relating to the water-powers of the state and the possibility of their improvement by storage reservoirs, natural and artificial. It is to work in conjunction with the State Survey Commission and with the U. S. Geological Survey in making a topographic map of the state. The law also requires that any work done for water-power development by private parties or corporations must have plans filed with the Commission. While the Commission is given comparatively little power and is provided with a total appropriation of only $5,000 per annum, it seems likely that the start thus made will be followed up until effective supervision over the waters of the state is established.

In the immense labor involved in the construction of a transit subway through the crowded streets of a city, the details of the heavy work, the excavation, tunneling, steel erection or concrete laying, far outweigh such minor matters as interior treatment or station planning and decoration. This is, of course, as it should be. The proper selection of a route and the efficient, cheap and safe construction of the main tube are the important considerations in such a work. However, the importance of the station is recognized by all subway builders. That it should be pleasing to the eye is desirable, because it is the only part of the structure where the passenger is apt to spend any length of time; that it should be cleanly goes without saying. Finally it must be safe, for there, and there alone on the system, is the passenger responsible for his own safety, and every aid must be provided to assist him in guarding that safety. Fortunately, the first two of these requirements are generally filled in our subways, but in the older ones the precaution of making stations safe for the passengers has been occasionally neglected. Any one who tried to stand on one of the island platforms of the 96th St. station of the New York Subway during the crushes of the recent Hudson-Fulton celebration will testify to the danger of at least one of the stations in this oldest subway in the country.

It is, then, on account of the very occasional reference in technical literature to subway station design that we wish to call particular attention to the leading article in this issue on the stations of the new Boston subway. In this tunnel, the latest of the American passenger subways, the greatest care has been taken in the stations. Each one is roomy, although there is the same defect in them that makes some of the New York subway stations dangerous, that is, the absence of a protecting fence along the platform edge. Such a fence is clumsy and difficult of effective design, but at the lower express stations in New York the recently installed sliding gates seem to serve the purpose. For ordinary service such a fence is useless but in crowds it is very necessary. In Boston, however, possibility of crowding is minimized by the separation of the entrance and exit passageways, thus avoiding the very common trouble of two pushing crowds trying to go through each other in opposite directions. Finally, the numerous station signs, the well-distributed lights, the cleanliness of the walls and floors which must result from the plane concrete and tile surfaces and the simple but neat decorative

features add considerably to the passenger's comfort and appreciation.

Aside from the general description, Mr. Manley's article possesses no little interest, because of the detailed account of the methods and costs of plastering, concrete finishing and tiling. In many cases, especially in heavy buildings, engineers are called upon to supervise this sort of work, but its details are generally left to the architect. In either case the architect or engineer who has had the necessary experience rarely records that experience for the benefit of his fellows, so that this exception is especially welcome.

In another part of this issue we have reprinted a portion of the offer of the Union Pacific Railroad to assist the technical education of its employes and prospective employes. In this article the following sentences will be noticed:

> This bureau . . . . will keep in touch with various universities, colleges, high schools and technical schools. . . . . Persons registering . . . may indicate the particular line of work which they desire to follow. They will be given every opportunity for learning the elementary methods and requirements of the department they wish to enter.

Here would appear to be an opportunity of advantage to those engineering graduates, or undergraduates even, who have leanings toward railroading, but who do not feel able to afford the special courses in railway organization and management which a few universities now maintain.

A Proposal to Force the Railways Entering Chicago to Adopt Electricity.

For two years or more, negotiations have been pending between the authorities of Chicago and the officers of the Illinois Central R. R., looking to the substitution of electric power for steam locomotives in the suburban traffic of that railway company. It was recently stated, apparently on good authority, that as a result of their investigation the Illinois Central authorities were not disposed to adopt electricity. At the meeting of stockholders on Oct. 20 a report would be made setting forth that if the stockholders desired to see their dividends reduced from 7% to 5% they might proceed to vote to electrify the company's Chicago suburban service!

The city authorities probably thought it unnecessary to wait for a vote of the stockholders thus advised, and they countered by introducing an ordinance* into the City Council on Sept. 27, compelling every railroad company in the city of Chicago to substitute electric power for steam locomotives on all its tracks within eight miles of the Chicago City Hall before Jan. 1, 1912.

*Be It Ordained by the City Council of the City of Chicago:

Section 1. That after the first day of January, A. D. 1912, every railroad company shall operate and propel any and all cars or trains within a radius of eight miles of the City Hall in the City of Chicago by electrical power.

Section 2. Every railroad company now operating or propelling cars or trains of cars in the City of Chicago, or now authorized by ordinance so to do, shall, within one year after the passage, approval and publication of this ordinance, submit to the Commissioner of Public Works of the City of Chicago plans and specifications for operating and propelling all of its cars or trains of cars in the City of Chicago by means of electrical power, as in Section 2 of this ordinance provided. If the manner in which any railroad proposes to operate its cars by means of electricity, as indicated by said plans and specifications, is one which in the judgment of the Commissioner of Public Works is reasonably safe, said Commissioner of Public Works shall approve said plans and specifications, and thereafter the railroad company presenting plans and specifications so approved shall proceed within six months to electrify its line of road as in and by plans and specifications provided, and shall continue said work with reasonable diligence.

Section 3. No railroad company shall propel or operate any car or train of cars within a radius of eight miles of the City Hall in the City of Chicago by means of any power other than that of electricity any time after one year from and after the passage, approval and publication of this ordinance unless at the time of so doing it shall have submitted plans and specifications to the Commissioner of Public Works, as by Section 2 of this ordinance provided, and such plans and specifications shall have been approved by said Commissioner of Public Works.

Section 4. Any railroad company which shall violate any of the provisions of this ordinance shall be fined in a sum not exceeding $200 and every day that any railroad company shall continue to violate any of the provisions of this ordinance shall be regarded as a separate offense and punished by a fine of not exceeding $200.

Section 5. This ordinance shall be in force and effect from and after its passage, approval and publication.

It was practically admitted by the responsible authorities of the city that the ordinance was intended as a club to compel the Illinois Central to take the desired action with its suburban trains, and that the enforcement of the ordinance would not be seriously contemplated. It is, of course, self-evident to any one familiar with actual conditions that it would be a physical impossibility for the railways of Chicago to electrify all their tracks within the eight-mile radius, in the little more than two years that remain before Jan. 1, 1912. On this ground alone the ordinance could be invalidated.

Unfortunately, the general public knows little or nothing about these matters. It sees and suffers from the smoke and gas from the locomotives, and it hails the introduction of an ordinance to compel all the railways to use electricity, as a step toward deliverance from what is undoubtedly a great public nuisance. What it does not at all understand is the magnitude of the task which it is laying upon the railway companies, and not only upon the railways, but upon the people who travel upon them and ship freight by them—in other words, upon the public itself.

It must be remembered that the railways have no source of income save what they draw from the carriage of passengers and freight. They are making no such margin of profit at the present time as to permit such an expenditure as the wholesale electrification that Chicago proposes, out of surplus earnings. How, then, shall the money be provided to accomplish this stupendous task? Take, for example, as a concrete illustration, the Illinois Central suburban service. Undoubtedly, electrification is more needed here than elsewhere, because the smoke from the trains causes more injury; but these trains are run for the conveyance of passengers, and if it is necessary to run them in such a manner as to produce no smoke, why should not the passengers pay the cost of transportation by this method? Does Chicago wish to see the suburban fares on the Illinois Central raised to a point which would pay interest on the increased cost of operation by electricity? This solution, we imagine, would please neither the passengers nor the railway company, for the higher rates of fare would divert a considerable part of the traffic to the rival street railway lines, and the net revenue of the railway might not be much larger than at present.

Of course, if the present rates of suburban fare yielded a large profit to the railway, this profit might be devoted to paying the charges on electrification, but unfortunately suburban traffic is about the least profitable that American railways handle. Most of our readers have probably heard of the classic remark of the railway president who said he would rather carry hogs than commuters—and this was not a reflection on the relative cleanliness of the two classes of patrons, but on the relative profit resulting to the company from their journeyings. Suburban traffic is unprofitable because it is concentrated in a very small part of the 24 hours. The whole plant, including tracks, stations, locomotives, cars, and staff of employees, must be adjusted to the demands of three or four rush hours out of the twenty-four, and there is very little work to employ it during the rest of the time.

The good people of Chicago, or at least the intelligent portion of them, ought also to bear in mind that in treating this matter the railways are obliged to consider not only Chicago, but other centers as well. If Chicago can compel the adoption of electricity, so also can St. Louis; so can St. Paul and Minneapolis; so can Boston—where, indeed, a strong public movement to compel electrification has been under way for two years; so also can Philadelphia, Cleveland, Buffalo, Pittsburg, Cincinnati—and so we might proceed. But such adoption of electricity for terminal operations is something for which no precedent exists to prove its financial possibility. It is true that at New York City the three wealthiest railway corporations in the United States have undertaken to operate their main passenger terminals by electricity. They are going to accomplish the task eventually, but at an expense which has swelled their capitalization out of all proportion to the increased facilities which have been obtained. Furthermore, these companies were forced to this step by the conditions in the tunnels through which entrance is gained to Manhattan Island. The fact that electricity has been adopted on three roads which enter New York City does not prove that it would be financially practicable in other cities and on other railways.

That relief from present smoke conditions in American cities is greatly to be desired will certainly not be denied; but the railway locomotives are only one of the causes creating the black pall of smoke which hangs over our industrial centers. It is, indeed, the railways' duty to do their share toward improving conditions; and work toward better methods and better appliances for hauling trains without the emission of smoke ought to engage the best attention of railway officers. In the present state of the art, however, for either city authorities or state legislatures to compel the adoption of electricity by railway companies in their terminals will probably result, in the long run, not only in great injury to the railways and their stockholders, but in harm to the best interests of the public as well.

The Reliability of Large Hydraulic Testing Machines.

Every engineer interested in any way in studying the strength of materials (and this includes a pretty large proportion of the profession) should notice the report in this issue on the calibration of the large hydraulic testing machine for full size bridge members at Phoenixville, Pa.

The report was made by Mr. Jas. E. Howard, who has for many years been in charge of the Emery testing machine at the Watertown Arsenal; and his name will be to most engineers a sufficient guarantee of the reliability of the main results. Those who may doubt should have their doubts removed by studying Mr. Howard's detailed account of his tests made to determine the percentage of error in the Phoenixville machine.

These tests on the Phoenixville machine are particularly important because there is an idea, pretty well ingrained in the engineering profession, that results obtained by hydraulic testing machines are unreliable. Just how this idea arose we do not certainly know, but we may make a guess which seems fairly probable, about as follows: In the very early days of the use of testing machines, quite a number were built of the hydraulic type, which were similar to the ordinary hydraulic press and used the ordinary hydraulic packing leathers, in which outward pressure upon the packing varies with the pressure in the cylinder. As soon as these machines were tested in comparison with lever machines, it was found that a large and variable percentage of the load applied to the plunger was absorbed in friction, and the results obtained with the machine computed from the pressure gage were therefore unreliable. Thus it came about that the lever machine entirely supplanted the hydraulic machine for all ordinary testing purposes. Engineering students were taught early in their courses that they must not rely upon the indications of hydraulic machines.

Of course this applied to the testing of ordinary specimens which can be handled in machines of moderate size. When it came to building machines for testing full-size members, the difficulties in constructing the lever machines were so enormous as to be well-nigh impossible to overcome. Engineers, however, were anxious to have tests of full-size members, and numbers of such tests were made, first on the rather crude machine at the Keystone Bridge Works, and in recent years on the very large machine built in 1890 at Phoenixville, Pa.

In all the years that the Phoenix machine has been used, however, there has been, undeniably, more or less of a cloud over its results, in the minds of the engineering profession. We lay this partly to the general prejudice against hydraulic

machines which undeniably exists; but the prejudice was given an apparently substantial basis some ten years ago by an alleged calibration of the machine, which appeared to show that its results were subject to the very large error of 17%, more or less.

Our own belief has always been that this alleged calibration must have had a gross error in it somewhere. From study of the construction of the Phoenix machine, we have always believed that its results were substantially correct—as nearly so as the work upon full-size members could reasonably require. It appeared to us to be so difficult for any considerable proportion of the enormous load upon the piston to be absorbed by friction, that there seemed no room for doubt that the error of the Phoenix machine should be exceedingly small.

Nevertheless, it is undeniable that many engineers have looked with more or less suspicion upon the Phoenix machine's records, and probably the machine has been made use of to a much less extent than would have been the case if its indications had been generally accepted as exact. It is of the utmost importance, therefore, that the profession should give careful attention to the authoritative determination by Mr. J. E. Howard, that the Phoenix testing machine *is* accurate—even more accurate, probably, than those who have defended its work hitherto have ventured to claim.

Mr. Howard's calibration of the machine in comparison with the Emery machine at the Watertown Arsenal has been complete and exhaustive. The results are so harmonious and so complete that we see no room whatever for doubt as to their reliability. Briefly stated, Mr. Howard finds that the friction of the Phoenix machine is in the neighborhood of 12,000 lbs. *at all loads*. This, indeed, is what might be expected from the construction of the packing around the plunger of the Phoenix machine, since the pressure on the packing does not vary with the water pressure in the cylinder.

There are some important conclusions to be drawn from these results of Mr. Howard's work. The first is that it is not necessary to go to the enormous expense of a lever machine, in order to provide the profession with what it so much needs—a testing machine large enough to load to destruction our heaviest types of compression members. As our readers will recall, there has been a movement on foot to commit the Government to the purchase and direction of a huge lever machine which Mr. Albert H. Emery has designed and the cost of which is estimated at something like $2,000,000. The bill before the last Congress to construct such a machine did not progress very far, and the results obtained by Mr. Howard should authoritatively settle the question whether it is worth while for the Government to go to such great expense. There can be no question, now, that the building of such a machine would be a needless extravagance.

On the other hand, now that the reliability of large hydraulic machines is established, the way is open for the construction of machines large enough to satisfy any reasonable requirement, and at an expense very modest compared with the cost of a lever machine. As our readers will recall, a very large machine of the hydraulic type is now being built by Mr. Tinius Olson for the Technologic Branch of the U. S. Geological Survey. There has been a certain amount of prejudice against this machine, we believe, simply because it is a hydraulic machine. Mr. Howard's tests ought certainly to set this prejudice at rest.

LETTERS TO THE EDITOR.

The Zuni Dam.

Sir: I notice in Engineering News of Sept. 30 a statement, probably taken from press dispatches, regarding the failure of the "Black Rock dam, which was built jointly by the Bureau of Indian Affairs of the Interior Department, and the United States Reclamation Service."

By reference to p. 74 of Schuyler's "Reservoirs for Irrigation," it will be seen that this dam was built by the United States Indian Service. Mr. W. H. Sanders, consulting engineer for the United States Reclamation Service, was consulted regarding a few details, but no officer of the Reclamation Service has ever had authority in connection with the construction of this dam.

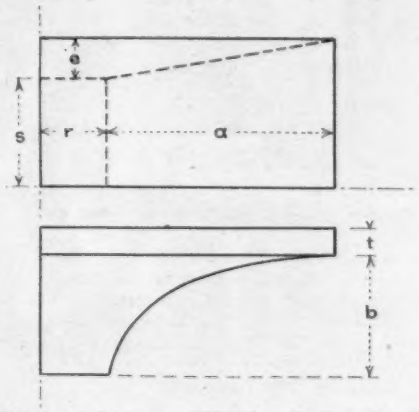
I am unable at present to state whether or not the report of the failure is correct, but the Bureau of Indian Affairs has had no report of this failure.

Very truly yours,
A. P. Davis, Chief Engineer.

Washington, D. C., Oct. 2, 1909.

Formula for the Volume of Material in Groined Arches.

Sir: The following is a formula for the calculation of masonry volume in groined-arch vaulting where the arch spans and pier dimensions are unequal in the two directions:



Volume of quarter arch section enclosed by lines through centers of piers and through centers of vaults, as shown in sketch,

$$= (b + t)\ (a + r)\ (e + s) - [0.942\ a\ b\ e + 0.7854\ b\ (a\ s + e\ r)]$$

Applying this, for example, to the main section of the Queen Lane reservoir, Philadelphia, we have

$a = e = 6.75$ ft.
$r = s = 1.25$ ft.
$b = 3.75$ ft.
$t = 10$ ins. $= 0.833$ ft.

Volume of quarter section =

$$4.583 \times 8.0 \times 8.0 - [0.9042 \times 6.75 \times 3.75 \times 6.75 + 0.7854 \times 3.75\ (6.75 \times 1.25 \times 2)]$$
$$= 293.3 - [154.5 + 49.7]$$
$$= 89.1 \text{ cu. ft.}$$

Charles B. Buerger,
Bureau of Water, Philadelphia, Pa.

Sept. 24, 1909.

[It should be added that the formula is exact. It applies to vaulting whose intrados is a full semi-elliptical barrel.—Ed.]

A New Stadia-Rod Design.

Sir: The stadia rod here illustrated was designed by the writer in 1902. Two rods from this design were then made for the department of civil engineering of Stanford University by the A. Lietz Co., of San Francisco. The two rods have been in regular use by the students in the classes in surveying. The students also make use of rods of various other designs. It has been observed that the rod here described is the favorite with the students, because as they say it is read with minimum effort at all distances. It has therefore seemed worth while to offer this design to others and to describe the method of selecting the design.

Method of Selecting the Design.—Each of the many styles of figuring a stadia rod known to the writer, was roughly reproduced on a strip of paper 4 ins. wide by about 6 ft. long by means of pencil, scale, water-color brush, and red and black inks. These strips were tacked up side by side on the side of a building, shaded by a porch roof. The writer then slowly backed away from the strips and noted which features of the markings of the several strips became indistinct and which features remained distinct at increasing distances. By this means was obtained a clear distinction between the weak and strong points of each design.

Several composite designs were then made on fresh strips of paper, combining in various ways the strong points of the designs previously tried out. The composite designs were then tested in the manner described above. This process of selection and combination was repeated until the design here illustrated was reached.

A little experimenting with the full length illustration (Fig. 1) held at varying distances from the eye will show the following characteristics of the design:

1. The simplicity of the design makes it easily comprehended and reduces to a minimum the chance of blunder in reading. The one thing to be borne in mind is that the bottom of each numeral (which covers a half-foot space) is the corresponding foot-mark.

2. For short sights the one-tenth spaces are readily sub-divided into hundredths of a foot by eye.

3. For medium sights the one-tenth spaces are readily counted, and the numerals are legible.

4. For long sights on which the one-tenth spaces cannot be counted and the numerals cannot be read, the rod appears marked into half-foot spaces by the numeral masses of black and red, and these half-foot spaces can be subdivided by eye to one-tenth foot, while the whole feet are read by counting the masses formed by the numerals, using the red numerals as reference points.

5. At extreme distances too great to permit of counting the half-foot spaces, the five-foot spaces, marked by the red numerals, may be subdivided by eye into half-foot spaces, or into one-foot spaces.

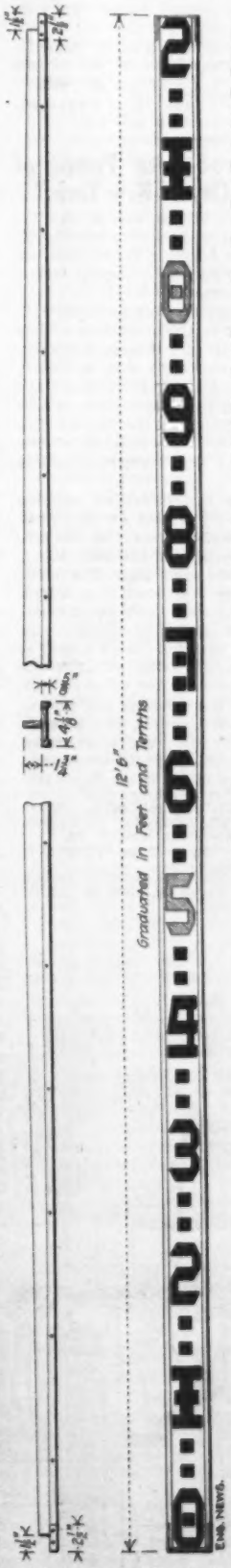


Fig. 1. Fish's Stadia Rod Complete.

It may be objected that this rod is not divided to hundredths. Markings for hundredths may be added without detriment to the design provided they are made so light in mass that they will practically fade from view at a distance at which they cannot be counted, leaving the tenth spaces unencumbered.

The specifications for this rod are as follows:

(1) All wood is well seasoned and straight in grain.

(2) Body of rod is pine.

(3) Side strips are ash, secured to body by 1¼-in. wood-screws of brass, spaced as shown on drawings.

(4) Stiffening rib on the back of the rod is sugar pine, ⅛-in. thick, tapering from 1⅝ ins. in the middle to 1 in. at the ends.

(5) Each end of rod is shod with ⅛-in. brass strip secured to the rod with six brass wood-screws, two on each side and two on the end.

(6) Face of rod is painted with three coats of flat white Jap-a-lac, time being given for each coat to dry hard before the next is applied.

(7) All other wood surfaces before assembling are oiled thoroughly with boiled linseed oil.

(8) Graduations are painted over the white in flat black and red. The face markings are accurately spaced, arranged and stamped in as shown on drawings.

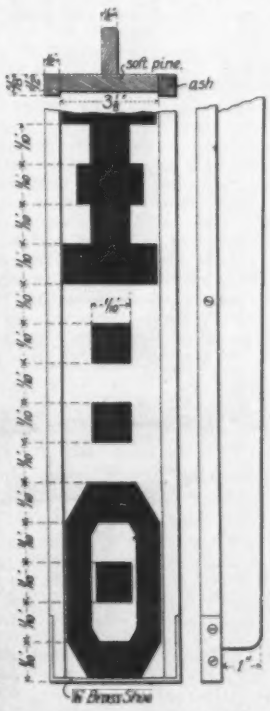


Fig. 2. Detail of Face of Rod.

(9) Bottom of numeral "1" is 1 ft. above the bottom of the rod, and the other numerals are placed in corresponding positions.

(10) Numerals representing ten, eleven and twelve are respectively "0," "1," and "2."

(11) Numerals "0" and "5" are red and all other numerals and marks are black.

The stiffening rib on the back of the rod was suggested by Mr. A. Lietz.

J. C. L. Fish.

Stanford University, Cal., Aug. 26, 1909.

Notes and Queries.

In Mr. F. H. Fowler's article on the Assuan Dam in the issue of Sept. 30, p. 339, in lines 5, 7 and 13, column 2, the decimal point in the amounts in dollars should be moved one place to the left.

A correction to the article by Mr. Geo. G. Anderson on the failure of the Bluewater Dam (p. 353 of last issue) reached us too late for insertion. The sentence near the end of the first paragraph should read:

"The reservoir contained at spillway level 2,600 acre-feet; at top of the embankment 4,200 acre-feet."

The High-Pressure Fire-Service Pumps of Manhattan Borough, City of New York.*

By R. C. CARPENTER†, M. Am. Soc. M. E.

The object of this paper is to present a concise description of the high-pressure pumping system installed for fire service in the city of New York and the results of a test of the pumping machinery.‡

The system protects the district extending north from City Hall to 25th Street, and east, approximately, from the North River to Second Avenue. It comprises about 55 miles of extra heavy cast-iron main, from 12 ins. to 24 ins. in diameter, with 8-in. hydrant branches; and two pumping stations so located that they never can be in the center of a conflagration. At the present time the pumping stations have a combined capacity of over 30,000 gals. per min. delivered at a pressure exceeding 300 lbs. per square inch.

The two stations, known as the Gansevoort pumping station, located near Gansevoort Market on the North River, and the South Street station, located on the corner of Oliver and South Streets near the East River, are identical in construction and equipment. The buildings are of simple design, of steel fireproof construction, with concrete foundations. The Gansevoort Street building, which is typical of both, is one story high with basement, 63 ft. 8 ins. by 97 ft. 4 ins. Each station is large enough for eight pumping units, although the present installation consists of only five units at each station. In the floor-plans of the buildings and general layout of machinery, piping, switchboards, etc., space is provided for three additional units. The arrangement is the same for both stations, the only difference being that the switchboard and office in the South Street station are on different sides of the building as compared with the Gansevoort station.

The motors and pumps, with suction and delivery branches, are located on the main floor of the pump room. The switchboard and switchboard apparatus are placed in an enclosed two-story and basement gallery. The four high-tension feeders and all other wires entering the building are brought in through the gallery basement, and all terminal work on the entering wires is located in the basement. On the first floor of the gallery, which is approximately on the same level as the pump-room floor, are placed the oil switches, with their controlling and protective devices, fireproof cells and compartments. The operating switchboard is conveniently located in the enclosing wall of the gallery, and is so placed as to allow a man standing on the pump-room floor to perform all the operations necessary for controlling the apparatus in the station. The bus bars, with their fireproof compartments, are placed on the second floor of the gallery.

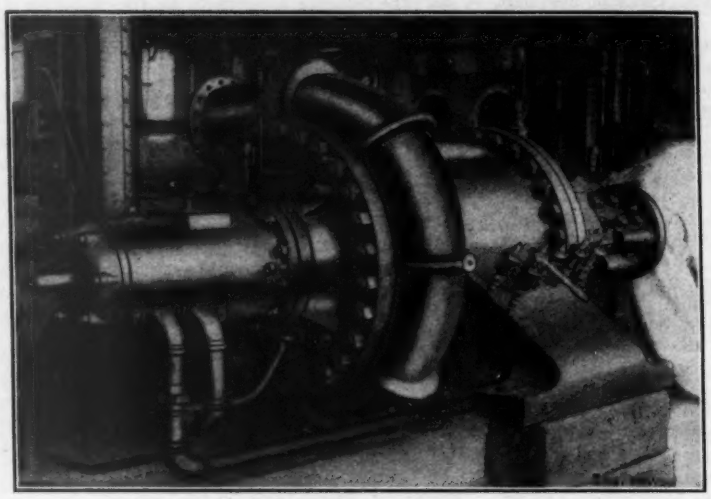


FIG. 1. FIVE-STAGE CENTRIFUGAL PUMP UNIT OF THE HIGH-PRESSURE FIRE-SERVICE SYSTEM OF NEW YORK CITY.

(Capacity 3,000 gals. per minute at 740 r. p. m., with 300 lbs. per square inch delivery pressure.)

Description of Machinery.

The five units in each station consist of Allis-Chalmers five-stage centrifugal pumps driven by Allis-Chalmers induction motors and the necessary auxiliary machinery. The motors and pumps are alike and their parts are interchangeable. The pumps each have a specified capacity of 3,000 gals. per minute of sea-water, working with a suction lift of 20 ft. and a delivery pressure of 300 lbs. per square inch. The actual capacity as indicated by a 24-hour test was about 30% in excess of that specified.

The original specifications contemplated the use of six-stage pumps, with the expectation that sea-water would be used at each fire. Because, however, the relative amount of water required for fire purposes is insignificant and sea-water may do considerably more damage to goods than fresh water, a change in the specifications was agreed to whereby the pumps should work at best efficiency when receiving water from the Croton mains at a pressure on the intake side varying from 10 lbs. to 40 lbs. per sq. in. To meet this new condition the pumps were all built with five stages. All the sea connections and priming machinery as originally contemplated were installed, so that sea-water can be pumped into the mains whenever desired. The effect of the change is merely to reduce the pressure head slightly in case sea-water is used.

PUMP MOTORS.—Each pump is direct-connected to its motor by a flexible coupling which takes care of any variation from alinement. The motors are of the constant-speed induction type, 3-phase, 25-cycle, 6,300-volt to 6,600-volt, designed to operate at about 740 r. p. m. The motors are of the wound rotor type and, in starting, an iron grid resistance is connected in the secondary circuit and gradually cut out by means of a hand-wheel on the motor-switchboard panel. When the resistance is all cut out the rotor is automatically short-circuited and operated by specially constructed solenoids which are operated by a small switch mounted directly on the shaft of the hand-wheel above referred to. An interlocking arrangement prevents the operator from closing the switch connecting the motor to the line while the rotor is short-circuited.

The specifications required the motors to have sufficient starting torque to attain full speed between 30 seconds and 45 seconds after starting, with a current not exceeding 150% of that used when the motor is working under full speed. Each motor was required to develop not less than 800 B. HP. when using current of 6,300 volts, 25 cycles, and under these conditions to have an efficiency not less than 92%, a power factor not less than 93%, and a motor slip not in excess of 2%. At three-quarters load the efficiency was not to be less than 92% and the slip not to exceed 1.5%. It was specified that the temperature of the motors should not rise more than 40% on a 24-hour test at full load, when measured by a thermometer, the air in the room being 25° C.

Prof. Geo. F. Sever, of Columbia University, tested

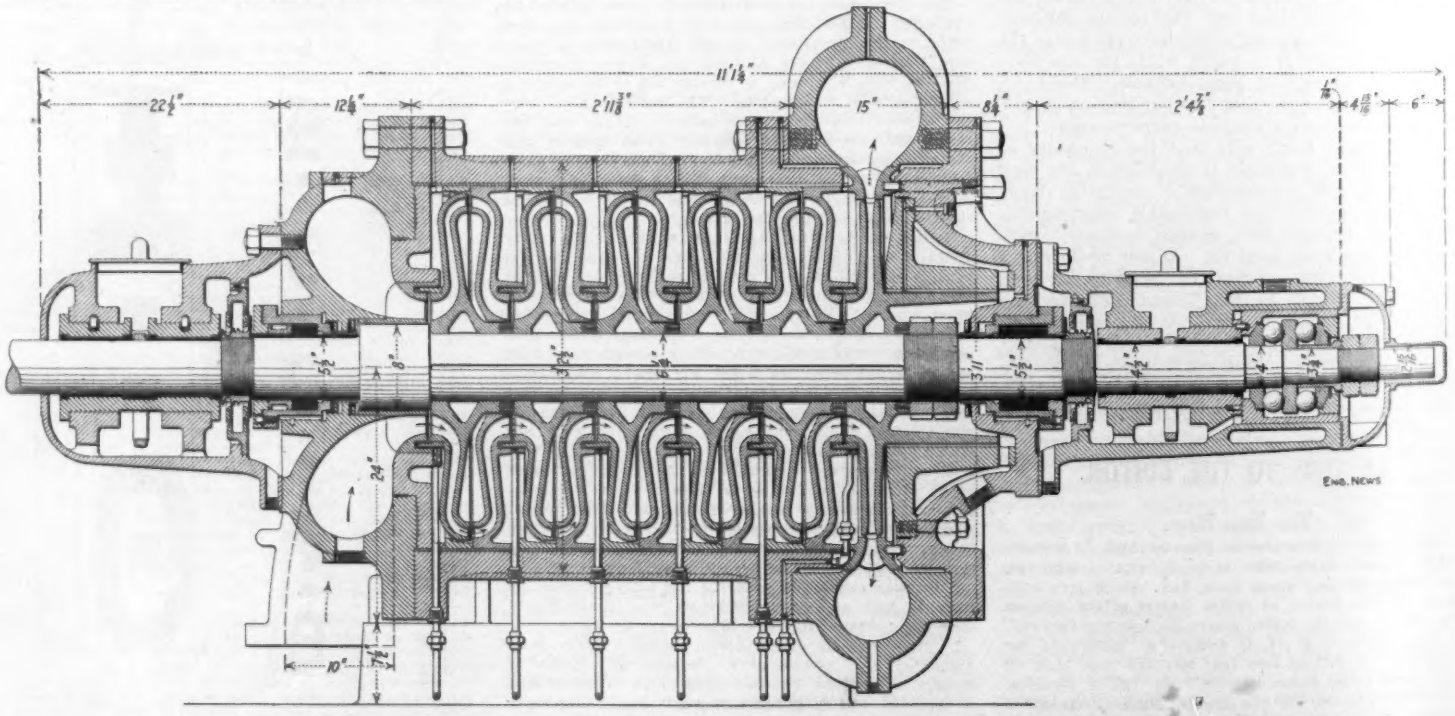


FIG. 2. SECTIONAL VIEW OF FIVE-STAGE CENTRIFUGAL PUMP FOR HIGH-PRESSURE FIRE-SERVICE, NEW YORK CITY.

*Abstract of an article in the "Journal" of the American Society of Mechanical Engineers for September, 1909, and to be presented for discussion on Oct. 12.

†Professor of Experimental Engineering, Sibley College, Cornell University, Ithaca, N. Y.

‡A detailed description of the high-pressure system was published in Eng. News, March 23, 1905, p. 317.

TABLE I.—EFFICIENCY TEST OF FIVE FIVE-STAGE CENTRIFUGAL PUMPS.
South Street Pumping Station, September 2 and 3, 1908.

Hour Beginning	r.p.m.	Total kw. per hr.	Total H.P. from motors (input)	Gals. per min.	Net pressure lbs.	H.P. delivered	Efficiency, per cent
12:30 p.m.		3875	4841.4	18334	309.4	3311.6	68.6
1:30	757.0	3851	4811.4	18634	323.9	3523.6	73.2
2:30	755.0	3829	4784.0	19217	321.4	3605.7	75.4
3:30		3819	4771.5	19220	320.2	3592.8	75.3
4:30	755.0	3811	4761.5	19145	319.0	3565.4	75.0
5:30		3837	4794.0	18995	311.8	3457.6	72.1
6:30	755.0	3818	4770.3	18970	310.5	3438.7	72.2
7:30	755.0	3815	4767.5	18980	311.0	3446.0	72.3
8:30	757.0	3863	4826.4	19020	311.7	3461.1	71.6
9:30	756.0	3868	4830.2	19120	315.2	3518.3	72.8
10:30	757.0	3873	4838.9	19095	312.0	3478.1	72.1
11:30	756.5	3859	4821.4	19120	312.8	3491.6	72.4
12:30 a.m.	757.0	3870	4835.2	19175	315.7	3534.1	73.0
1:30	756.5	3672	4587.8	18790	302.0	3315.0	72.5
2:30	757.0	3667	4581.6	18776	300.0	3288.4	71.5
3:30	757.0	3890	4860.2	19190	316.3	3543.5	72.8
4:30	757.5	3891	4861.4	19160	315.6	3530.2	72.6
5:30	754.7	3861	4823.9	19110	317.1	3337.7	73.2
6:30	757.0	3865	4828.9	19005	314.8	3492.7	72.4
7:30	754.7	3706	4630.4	18710	308.6	3370.8	73.0
8:30	745.6	3659	4571.5	18100	309.7	3272.5	71.5
9:30	745.6	3651	4536.5	17890	308.9	3226.2	71.5
10:30	745.0	3619	4521.6	17795	312.2	3243.4	71.8
11:30	747.0	3618	4519.1	17806	313.3	3256.8	71.8
Average	756.1						72.5

Average efficiency, 1st period of 8 hr. = 73.0 per cent.
Average efficiency, 2nd period of 8 hr. = 72.3 per cent.
Average efficiency, 3rd period of 8 hr. = 72.5 per cent.
No. of cycles per sec. 12:30 p. m. to 6:30 a. m. = 25.5
No. of cycles per sec. 6:30 a. m. to 12:30 p. m. = 25.0

two of the motors in the shops of the contractor and found them to meet the specifications and to have a full-load efficiency of 93.2%. The other motors were inspected and found to be alike and were assumed to have the same efficiency. The motors were also tested for temperature rise at the time of the official test to be described later.

PUMPS.—The pumps were constructed with five stages, each to give a pressure of somewhat over 60 lbs. per square inch, making the combined pressure of the five stages about 300 lbs. per square inch above the intake pressure, which is the maximum working pressure of the stations at normal speed of 740 r.p.m.

The pumps are water-balanced by a piston connected to the last impeller and upon which the water pressure

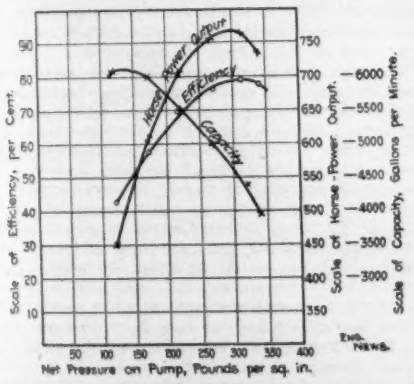


Fig. 3. Curves Showing Results of Test on Separate Five-Stage Centrifugal Pump Unit.

acts, but should any additional end-thrust occur, it would be taken up by the ball bearing provided in the outboard bearing. This ball bearing consists of two rings of 1½-in.-diameter steel balls and is water-cooled. The balancing piston is fitted very loosely in order to keep the friction losses small, and as a result a considerable amount of water leaks past it into a chamber at the end of the pump, which is provided with a discharge pipe and valve leading into the suction. By adjusting the valve in this pipe the difference of pressures on the piston can be regulated as desired.

The bearings are of the ring-oiled type and are separated from the pump casing by packing glands which prevent foreign matter from entering the bearings. The impellers are of bronze and the shaft of forged steel. All parts of the runners and diffusion vanes are thoroughly lubricated by oil cups on the base of the pumps, shown in Fig. 1. A feature is the wide base which allows the pump barrel to set low, giving stability. Each combined unit is equipped with automatic and hand control. The pumps are kept primed for instant service and the simple operation of a switch on the main switchboard starts the machine and gives full pressure in about 30 secs.

A combined regulating and relief valve is interposed between the discharge pipe and the suction pipe of each pump, and set to regulate the discharge of each pump to any predetermined pressure. When the volume of the water discharged by the pump is in excess of that forced into the system, this valve acts as a relief valve and bypasses this excess into the suction to the pump, the pressure on the main distribution system remaining at the predetermined point. When no water is forced into the distribution system, all of the water discharged from the pump is bypassed into the suction. The pressure-regulating valves were made by the Ross Valve Mfg. Co., of Troy, N. Y., and much of the practical success of the station has been due to the accuracy with which they maintain any desired pressure.

The priming apparatus in each station consists of three motor-driven vacuum pumps, each arranged to maintain automatically a vacuum of 26 ins. in the suction lines. These pumps are of the piston single-action type, one having a displacement capacity of 300 cu. ft. per minute for a piston speed of 200 ft. per minute, and each of the others a displacement capacity of 50 cu. ft. with a piston speed of 160 ft. per minute. An air-collecting chamber is connected to each of the salt-water suction lines and equipped with water-gage glass and vacuum gage. The air-suction piping between the air chambers and the air pumps is provided with a vertical loop sufficiently high to prevent water being carried over to the pumps. The air pumps are interconnected to each air chamber.

Venturi meters for measuring the discharge of water from the station and from one main to the other were set by the contractor on each discharge main and on the cross-connecting main. The meters of the discharge main are 24 ins. in diameter and on the cross-over main 12 ins. in diameter. These meters were provided with dial-indicating gages and also chart-recorders graduated to indicate the flow in gallons per minute, and in addition with an integrating meter which registers the total flow in gallons. The readings during the test were taken by a mercury manometer, graduated to show the capacity in thousands of gallons per minute.

Tests.

The specifications for the pumping system provided for an endurance test of each motor and pump lasting 24 hours without stop, during which time the capacity and efficiency of the pumps and motors was to be determined. The specifications provided for making the test with sea water, but this was later changed to a test with Croton water under the conditions of actual use. In view of this change the contractor increased the efficiency guarantee from 70 to 71%.

The original specifications called for a capacity of 3,000 gals. of sea water per minute against a discharge pressure of 300 lbs. per square inch, and a suction lift not exceeding 20 ft. The total increment of pressure is equivalent to 308.66 lbs. from the intake to the delivery side. The Croton pressure varies at the stations in different parts of the day from about 40 lbs. to 13 lbs. per square inch, and is affected by the amount of water being drawn from the mains. Consequently, to meet the requirements, the delivery pressure would need to be 308.66 lbs. in excess of the intake pressure. There is also a further correction from the fact that sea water is heavier than fresh water and this correction under maximum conditions might amount to 2.5%.

The specifications further provided that if the aggregate of all stops exceeded one hour for any motor, the test for capacity for such motor was to be run over again for a period of 24 hours, and that the pumping capacity of the apparatus and the efficiency of the pumps should be based on the minimum rate of pumping during any eight consecutive hours of the endurance test, during which none of the motors were stopped.

The modified specifications required that the efficiency of *each pump* should be not less than 70% and its capacity not less than 3,000 gals. of sea water when lifted to a pressure equivalent to 308.66 lbs. To determine whether the requirement was met, a separate test of each pump was required.

OLIVER STREET STATION TEST.—The test of the South street station was begun on Sept. 2, 1908, after about 2 hours of preliminary running for the purpose of adjusting the delivery pressure; it was continued without interruption for 24 hours. With the exception of a short stop of motor No. 2 which was shut down from 2.11 to 2.41 a. m., Sept. 3, to remedy a slight defect in the insulation of the field coils, no pump was stopped. During the time No. 2 was stopped the pressure on the delivery mains fell to about 300 lbs.; during the remainder of the test the pressure was maintained at or above the contract requirement, as will be noted by consulting the sixth column of Table I.

The average results for each hour for the 24-hour test of all four motors are given in Table I. It will be noted that the delivery every hour was largely in excess of the contract requirement of 15,000 gals. The smallest delivery for eight consecutive hours occurred at the last part of the test, when the average capacity, as shown by the readings, was 18,447 gals. per min., and the average efficiency was 72.2%. During this time the average pressure pumped against was 314.5 lbs., or an excess of about 6 lbs. over contract requirement.

It will be noted from the last column of Table I. that there is considerable variation in the efficiency; that during the first hour the efficiency was less than 70% whereas, during the third, fourth and fifth hours the efficiency exceeded 75%. This variation in efficiency was doubtless caused by variation in the amount of water bypassed from the pressure to the suction side of the pump over the balance piston and through the bearings, and possibly during the first hour by the discharge of some water through the relief valve which was pumped but not metered. The valves for regulating the differential pressure on the balance pistons were nearly closed during the third, fourth and fifth hours of the South Street station test, but were opened the normal amount for the remaining portion of the test.

The amount of water which may leak for maximum difference of pressure around the balance piston of any pump without passing through the meter could not be accurately determined, but was estimated to be in excess of 4%. Hence it appears that slight changes in the opening of the valve controlling the differences of pressure at this piston must materially affect the efficiency. The normal opening of this valve appears to correspond to an efficiency of about 72.5%.

During the test of the South Street station, all the bearings ran cool with the exception of those on No. 6 pump, which heated up during the third and fourth hours, but were brought to a normal condition, without stopping the pump or reducing its load, by the application of lubricants and cooling water.

It will be noted from Table II. that the average results of the 24-hour test of the South Street station exceeded the contract requirements in capacity, pressure head and efficiency. The horsepower delivered by the motors during the test averaged for the 24 hours about 920, or about 15% above rating, without excessive heating.

Immediately after the close of the endurance test of 24 hours, a short test was run on each motor separately, which was continued long enough after uniform results were shown to obtain 12 to 15 readings. The results of this test showed that the individual pumps operated singly had an efficiency from 4% to 6% in excess of the average when operated together, and that the capacity for the specified discharge pressure was considerably in excess of the requirement of the specification. It is, I believe, generally the case that individual centrifugal pumps delivering water into a main singly show a greater efficiency by from 4% to 6% than the same pumps delivering together into a single main, due probably to less loss in eddy currents and friction head, etc.

GANSEVOORT STATION TEST.—The endurance test of the Gansevoort station with all the pumps in opera-

TABLE II.—TEST OF INDIVIDUAL CENTRIFUGAL PUMP UNITS.
Gansevoort and West Street Stations, September 6, 1908.

Time	No. of pump	Elect. H.P. Input	Gals. per min. Hg. Col.	Pressure delivery	Lbs per Sq. in. Injection.	Lbs per Sq. in. Net	H.P. output	Efficiency of pump
10:05–10:31	1	916	3800	356.8	35.4	321.4	711	77.6
10:36–10:51	2	877	3800	350.8	35.1	315.7	700	79.8
10:54–11:12	3	920.5	3820	350.4	34.1	316.3	703	78.0
11:17–11:30	4	802	3751.4	352.5	35.6	316.9	695	77.7
11:37–11:53	6	899	3880	350.9	35.2	315.7	714	79.4
11:55–12:03	6	880.3	3457	376.1	36.0	340.1	686	77 9
12:03–12:07	6	929	4500	304.4	34.6	269.8	708	76.1
12:09–12:13	6	946	5070	255.6	33.6	222.0	654	69.4
12:24–12:26	6	952	5500	207.4	33.2	174.2	550	58.7
12:33–12:36	6	927	5588	155.2	33.2	122.0	397	42.8

Immediately following the 24-hr. test for capacity.

tion was begun at 9.45 a. m., Sept. 5 after the pumps had been operated for about 20 minutes, giving uniform results, and this was continued for 24 hours. The method of testing was the same as described in reference to the South Street station. For this station, the efficiency average for 24 hours was 72.9%, with a variation (excepting the first hour) of less than one-half of 1%. It fell below 70% during the first hour, which was due to the opening of an automatic relief valve on pump No. 2, which discharged some of the water into the suction before it had been metered. For that reason the efficiency during the first hour has not been considered in determining the performance of the pumps.

The least capacity during the eight consecutive hours when all the water pumped passed through the meters occurs from 10.45 a. m. to 6.45 p. m. The average capacity during this time is 17,419 gals., or about 16.5% above that guaranteed. The average net pressure in pounds is 324.3 which is nearly 16 lbs. in excess of the contract requirements. The average capacity for the entire test is 17,867 gals., which was obtained with an average speed of 753.6 r.p.m.

Immediately after the completion of the endurance test of 24 hours' duration, each pump was tested when operating alone with results similar to those for the South Street station. The individual pump test at the South Street station shows a variation in efficiency from 70% to 77%, and at the Gansevoort station from 76% to 79%. This variation may have been due to the structure of the pumps, but in my opinion is more probably due to variable leakage past the balancing piston or through the relief valves. Pump No. 6 at the Gansevoort station was tested with varying openings of the valve in the discharge pipe. The results are shown in Table II. and also in Fig. 3.

PRACTICAL RESULTS.—The high-pressure fire system in New York, which was put officially into service on July 6, 1908, has been successfully operated at many fires, but it had a crucial test on Jan. 7, 8, and 9, 1909, when it was brought into service for five simultaneous fires, three of them of more than the usual extent and activity, and one particularly so. Information upon the results attained with the system and the amount of water consumed was given by Chief Engineer I. M. de Varona, and published in Engineering News in the issue of Feb. 11, 1909.

The high-pressure system was designed by I. M. de Varona, Chief Engineer of the Department of Water Supply, Gas and Electricity of New York. It was also constructed under his supervision. The construction of the electrical machinery was supervised by Prof. Geo. F. Sever as Consulting Engineer. The details of construction were in charge of Thomas J. Bannon, John P. Reynolds and Henry B. Machon, Assistant Engineers of the department. The machinery of each station was designed and erected by the Allis-Chalmers Co., of Milwaukee, Wis.

Making Concrete Waterproof.*

By IRA O. BAKER,† M. Am. Soc. C. E.

Concrete is very largely employed in many building constructions, and in some situations it is very important that it should be at least practically waterproof. There are several methods of rendering concrete more or less impermeable to water, some of which are simple and free to any one, and some of which consist in using secret or patented compounds. Of the former the simplest method consists in mixing hydrated lime or finely divided clay with the concrete, thus at least partially filling the voids or interstices in the concrete and decreasing the percolation of water. Another simple method consists in mixing powdered alum with the cement and dissolving ordinary soap in the water to be used in mixing the concrete. Although the latter materials have been used for more than 60 years as a wash for rendering masonry impervious to water, and although in recent years they have frequently been employed as ingredients of concrete to make the entire mass impermeable, the proportions to be employed and the reason for the effect seems to have had little or no scientific consideration, at least the proportions used in practice vary very widely. For the purpose of securing data for use in the revised edition of the writer's Treatise on Masonry Construction, now in preparation, certain investigations and experiments have been made; and it is the object of this article to present these results more fully than can be done in the book mentioned.

Alum and Soap Waterproofing Compound.

To use the alum and soap method of decreasing the permeability of mortar or concrete, the alum in powdered form may be mixed with the dry cement or the sand, and the soap may be dissolved in the water employed in mixing the concrete; or both the alum and the soap may be dissolved in the water. The former is probably the safer method in practice, since with the latter method the water must be thoroughly stirred while the two are being mixed or the precipitate may form in large masses which it is practically impossible to break up; and further the water must be kept stirred to prevent the compound from accumulating on the surface. These are conditions that it is not always easy to be certain of securing. However, the alum is more easily dissolved than the soap; and hence the alum may be dissolved in, say, one-fifth of the water and the soap in the remaining four-fifths, and then the two portions may be mixed together, being careful to stir them as the mixing progresses. The alum and the soap combine and form a finely-divided, flocculent, insoluble, water-repelling compound which fills the pores of the concrete and decreases its permeability.

The best proportions are: alum 1 part and hard soap 2 parts, both by weight. Soap varies in its chemical composition, and hence a single proportion can not be stated which will be chemically exact for all cases. The above proportion is in round numbers the relative combining weights of alum and average hard soap; and hence it is the best proportion to use, although widely different proportions have been used in practice with success. Any reasonably pure soap will do; but if soft soap is employed, a greater amount should be used in proportion to the amount of water in it.

It is difficult to dissolve more than about 3% of hard soap in cold water; and hence this practically limits the amount of alum to 1.5% and of the soap to 3%. These amounts will give a precipitate equal to about 3% of the weight of the total water. The amount of precipitate formed in the pores of the mortar or concrete will depend upon the amount of water used in the mixing. Of course, if it were desired to use a greater quantity of soap and alum, the soap could be first dissolved in a smaller quantity of hot water, which is afterwards mixed with the water used in making the mortar; but this is hardly practicable, nor necessary, as will appear presently.

An excess of alum does no harm, since alum alone is a fair waterproofing material. An excess of soap does no harm; and an excess is better than a deficiency, since the excess will unite with the free lime of the cement and form calcium soap—a finely-divided, water-repelling compound which is apparently the essential element of several of the proprietary waterproofing compounds. The above is the explanation why such diverse proportions of alum and soap give reasonably successful results in actual practice.

Effect of Water-Repelling Compound.

A film of oil on the wires of a moderately fine sieve makes it nearly, if not quite, water-tight. The question then naturally occurs: Can a water-repelling compound in the concrete act in the same way as oil on a sieve? Or in other words, can a volume of water-repelling compound less than the volume of the voids in the concrete decrease the permeability of the concrete in a greater ratio than the per cent. of the voids filled? If so, then a water-repelling compound is more efficient in decreasing the permeability of a concrete then a mere void-filling material.

To test the effect of a water-repelling ingredient upon the permeability of concrete, a series of experiments were made under the writer's direction by Mr. B. L. Bowling in the cement laboratory of the University of Illinois. The experiments consisted in molding a series of Portland cement mortar disks in short lengths of 6-in. pipe, subjecting these disks to water under pressure, and measuring the amount of percolation. For convenience in making the experiments, mortar was used instead of concrete. The mortar for the treated and the untreated disks was alike except for the alum and soap compound. However, the mortars containing the alum and the soap were invariably drier than those made without these ingredients; but this probably has no significance in this connection. An annulus, 1-in. wide, at the circumference of both the top and the bottom faces of the disk was coated with hot asphalt, and also covered with a rubber gasket against which a flat casting was pressed by bolts through an external flange; and consequently the flow was through a disk 4 ins. in diameter and 2 ins. thick. The percolating water was caught in a tin funnel, the top of which fitted closely against the lower casting and the neck of which passed through a perforated rubber stopper into a bottle. The water pressure varied from 40 to 45 lbs. per sq. in. The date and the results of the experiments are given in the accompanying table. Tests 1 and 2 were made together, as also tests 3 to 6, and 7 to 9. The intention was to have four tests in each series, but through one reason or another some of the tests were of doubtful value or were useless, and hence are not reported.

The mortar used in making the disks was 1:6, which is unusually lean and porous, but it was purposely made porous the better to test the effect of the alum and soap compound. Known weights of cement, sand, and water were used, and the volume of the mortar produced was measured; and then knowing the specific gravity of the several ingredients, the density of the resulting mortar was computed by a process not necessary to explain here. The voids in each disk are stated in the table, and ranged between 23.4 and 24.0%. If the sand had not been well graded, the per cent. of voids would have been considerably greater, and also the individual voids would have been larger. A 1:2:4 concrete made of well-graded sand and stone would have only about 13 to 15% of voids.

The amount of water used in making each of the several disks is stated in the table. Knowing the percentage of alum and soap in the water and the amount of water used in mixing, it is easy to compute the amount of the precipitate in the mortar. The amount of precipitate in each disk is given in the table.

The percolation for each of several successive 24-hour periods is given in the table. The results show that the alum and soap precipitate is quite effective in decreasing the percolation. In the first series of experiments, Nos. 1 and 2, the alum and soap compound equal to 1.2% of the cement stopped a little over 76% of the percolation during the first 24 hours; and the corresponding results for the other series are 54 and 69%, respectively. The variation in the several series is surprisingly large, but it is certain that the experiments were carefully made; and the range in the results probably indicates the effect of undetected inequalities in the materials, the proportions, and the mixing.

Somewhat similar results were obtained for each of the successive 24-hour periods. The decrease in percolation through the treated and also through the untreated disks is due to two causes, viz.: (1) The percolating water doubtless has in it some solid matter, which clogs the pores of the upper surface of the disk. However, the water employed was that in the city water mains and was reasonably free from solids; (2) the percolating water takes up the soluble portions of the mortar from the upper part of the disk and carries them to the lower part. It is universal experience that all masonry becomes more nearly water-tight after use. It is interesting to note that in this series of experiments the average percolation during the twelfth 24-hour period was only 2.6% of that during the first period.

The most interesting feature of these experiments is that the alum and soap compound equal to an average of 1.2% of the cement in a mortar containing an average of 23.7% voids, stopped 65% of the percolation; or, in other words, adding water-repelling void-filling material equal to approximately 5% of the voids reduced the percolation to one-third of that of untreated mortar. One can hardly conceive that an equal amount of a non-repelling void-filling material would be equally effective. Apparently then the alum and soap compound in the concrete acts like oil on the wires of a sieve. The experiments are being continued to determine the effect of the alum and soap compound with less porous mortars.

The mixing of alum and soap in the concrete reduces its strength somewhat; but there are many situations in which strength is unimportant, or at least is less important than water-tightness. The effect of the alum and soap upon the strength of the mortar varies a little with the method of storing the test samples. For example, the mean of six neat Portland cement briquettes mixed with 21% of water which contained ½% of alum and 1½% of new "Ivory" soap, when left in the molds 1 day and stored in a moist chamber of 6 days, had a strength of 87% of that of similar briquettes made with water alone; and when left in the molds one day and then stored 6 days in water had 84%; and when twice as

TABLE SHOWING EFFECT OF ALUM AND SOAP ON PERMEABILITY OF CEMENT MORTAR.

Test No.	Water in per cent. of dry Mat.	Precipitate. Per cent. of cement.	Precipitate. Per cent. of voids.	Percolation, in Grams per 24 Hours. 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	10	0	23.4	945	155	94	61	51	34	30	26	18	14	14	12	....	....
2	10	1.2	23.6	224	37	21	12	10	6	5	4	2	2	2	2	12	6
..	..	...	....	....	....	....	....	....	....	....	....	....	....	....	....	2	2
3	12	0	23.9	1,113.0	342.3	195.0	166.6	132.7	120.4	98.0	78.5	61.4	55.5	52.8	44.9	....	....
4	12	0	23.9	1,061.2	330.6	178.4	145.0	123.2	107.7	66.3	49.8	41.1	37.6	36.3	30.6	....	....
		mean		1,087.1	336.4	186.7	155.8	127.9	114.0	82.1	61.6	51.2	46.5	44.5	37.7	....	....
5	12	1.4	24.0	497.8	206.8	122.3	76.7	64.2	58.2	36.0	25.0	21.0	19.5	17.0	15.0	....	....
6	12	1.4	24.0	517.0	222.2	132.2	87.7	72.1	65.1	39.4	26.1	21.7	19.5	16.9	16.2	....	....
		mean		507.4	214.5	127.2	52.2	68.1	61.6	37.7	25.5	21.3	19.5	16.9	15.6	....	....
7	12	0	23.9	1,101.1	324.0	150.9	108.4	84.8	79.2	56.6	50.1	48.9	35.5	31.0	29.2	47.3	21.5
8	12	2.8	24.0	339.5	221.2	114.8	75.2	54.4	50.4	33.3	33.7	28.0	20.2	17.3	16.0	25.5	11.0
9	12	2.8	24.0	333.8	213.4	118.6	74.9	52.2	47.6	31.5	32.0	25.4	18.0	16.3	14.3	22.3	10.2
		mean		336.6	217.3	114.2	75.0	53.3	49.0	32.4	32.8	26.7	19.1	16.8	15.1	23.9	10.6

*From "The Technograph" (the annual of the Engineering Societies of the University of Illinois), No. 23, 1908-09.

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much alum and soap were used, the strength was 83 and 71%, respectively.

A Better Water Repelling Compound.

Instead of using alum and soap as above, it is better to substitute aluminum sulphate (sometimes, but improperly, called alum) for the alum. The aluminum sulphate is cheaper than alum, and only about two-thirds as much of it is required; and the compound formed is equally water-repelling. The best proportion, in round numbers, is: 1 part of aluminum sulphate to 3 parts of hard soap, both by weight. Aluminum sulphate equal to 1% of the water and hard soap equal to 3% of water will give a dry precipitate equal to 2.5% of the water.

As with the alum and the soap, an excess of either of these ingredients does no harm; but an excess of soap is better than an excess of aluminum sulphate, since the soap unites with any free lime in the cement and forms calcium soap, which is a better waterproofing material than the aluminum sulphate alone.

Apparently no attention, except possibly by the manufacturers of proprietary waterproof compounds, has been given to the relative effect of capillary repellent and capillary attractive compounds.

One of the best means of making mortar or concrete waterproof is to make a dense mixture, i. e., to use plenty of cement and well-graded sand and broken stone; but nevertheless there are circumstances in which it is desirable to use a waterproof wash or to make a moderately lean mixture impermeable by adding a waterproofing ingredient to the mortar or the concrete. Either pair of the above ingredients is excellent when used as a wash to make a wall waterproof, as for example a cistern. To use them for this purpose, make solutions of the alum or the aluminum sulphate and of the soap of the proportions stated above; and then apply one of the solutions to the wall, and when it has dried apply the other. Apply as many pairs of coatings as may be necessary, which will usually be only two or three. It is better to apply the solutions hot; and it is important that they should be well rubbed on, but it is vital that they shall not be rubbed to form a froth.

Notes from Engineering Schools.

UNIVERSITY OF MICHIGAN.—Courses in railway administration have been arranged in the academic, law, engineering and economics departments for students desiring to fit themselves for railway work. These courses have been placed in four general groups for (1) those entering purely administrative branches, (2) those desiring to become statisticians or economic investigators on public service commissions, (3) those becoming appraisers for investors, (4) those studying transportation problems as part of their general education.

A RAILWAY ACCIDENT IN ITALY at Rezzato, Lombardy, Oct. 2, is reported to have caused the death of 20 persons. The Milan express crashed into another train which was waiting at the depot.

A COAL-MINE EXPLOSION at Roslyn, Wash., Oct. 3, killed eight men and injured several others in the No. 4 mine of the Northwestern Improvement Co. The mine was set on fire by the explosion and a number of buildings near the mouth of the shaft were ignited by cinders from the mouth of the shaft.

An explosion in the mine of the Wellington Colliery Co. at Nanaimo, B. C., Oct. 5, caused the death of 30 miners and injured 25 others.

THE CAVE-IN OF A TUNNEL under construction for the New Haven Water Co. in Orange, Conn., Sept. 28, killed four laborers. The tunnel was being driven from Alling's Mill to Lake Maltby. The men killed were at work 600 yds. from the tunnel entrance when the roof caved. The accident is ascribed to weakening of the tunnel roof by the water of a brook which flowed across it.

THE AXLE OF A STREET-CAR BROKE at Pittsburg, Pa., Oct. 3, while the car was rounding a corner at considerable speed. The car slewed and overturned, killing two passengers and injuring eight others.

A heavily loaded street-car was wrecked at Seattle, Wash., Sept. 24 near the main gate of the exposition grounds. One passenger was killed and 27 were injured. The car got beyond control and left the track at a curve.

A PASSENGER TRAIN of the Pennsylvania R. R. was struck by a string of freight cars at Youngstown, Ohio, Oct. 1. The passenger train, No. 215, was running at full speed. The freight cars, which were being backed out along a siding from a steel plant, struck the passenger train near its forward end overturning the baggage car. The passenger locomotive broke loose from its tender and train which were stopped by the air-brakes. The fireman of the passenger was thrown out at the time of the collision and the engineer fell from the cab a mile further on. The locomotive continued to run wild through the city and finally collided with a switch engine near the upper works of the Carnegie Steel Co. Both engines were wrecked and the crew of the switch engine suffered severe injuries.

FIVE DAMS WERE DESTROYED at Fergus Falls, Minn., on the morning of Sept. 24 by a flood on the Red River of the North. There was not an unprecedented rise of water on the river, but the first dam to go out, a structure with solid concrete spillway and adjacent earth embankment with a concrete core-wall, storing water for a municipal electric lighting plant, held back a considerable amount of water, which on being released caused a very high-crested flood to batter upon the smaller and weaker dams down-stream. These lower dams were used by mills with the exception of one which furnished storage for power for the city water-works, so that the city's industries and public services were both paralyzed. Fortunately, the banks of the stream are high so that no great damage to buildings occurred, although several bridges were damaged to some extent.

It is reported that the concrete dam which was first to go out was founded on sand and clay of a more-or-less pervious nature and that failure was due to undermining from percolation.

A HEIGHT OF 1,600 FT. was reached in an aeroplane flight by Orville Wright at Potsdam, Germany, on Oct. 2. The distance quoted is only very approximate, being estimated by the aviator from the time required to rise to the highest point reached. The ascent was made in 15 minutes and the descent in five.

Mr. Wilbur Wright made a notable flight of some 20 miles from the military reservation at Governor's Island, in New York Harbor, on Oct. 4. After rising above the island he proceeded up the Hudson River to about 125th St., passing over all sorts of river craft and over the warships of England, France, Germany, Italy and the United States, assembled for the Hudson-Fulton celebration. The return was made over the same course and he landed at the starting point. The total time of the flight was about 33 minutes. The height at which the machine flew varied from 30 to 300 ft.

THE WIRELESS-TELEGRAPH STATIONS, established along the British coasts by the Marconi company and the Lloyd's association, have been taken over by the British Post Office and will be operated in the future as a part of the general telegraph system. The three long-distance stations at Poldhu, Cornwell and Clifden were not included in the sale and the Marconi company will continue to operate them for transatlantic messages. It is reported that $75,000 was received for seven stations, including buildings, equipment, land, leases, telegraph rights, and control of patents and improvements which may be made in 14 years.

THE "MAURETANIA," the Cunard transatlantic liner which has made and broken innumerable ocean records, reduced the time of passage between Daunt's Rock and the Sandy Hook lightship, on the trip ending at New York Sept. 30, to 4 days 10 hrs. 51 min. This is a reduction of 44 minutes and the feat was accomplished in spite of rough weather on two days. The average speed for the trip was 26.06 miles, a new record also.

THE SENATE COMMITTEE ON IRRIGATION, whose Chairman is Senator Thomas H. Carter, of Montana, has visited the U. S. Reclamation Projects in Montana, Oregon, Idaho, Washington, Wyoming, South Dakota and Nebraska during the last month. The committee has adjourned until Nov. 1, when another trip will be taken to visit projects in Colorado, Utah, Nevada, California, Arizona and New Mexico. It is stated that the committee has been so pleased with the character of the work and its success, that it favors a large extension of the work. The rate of progress is now limited by the income from the sale of public lands, enabling expenditure to be carried on at the rate of about $8,000,000 per annum. It is stated that the Committee will recommend to Congress a bond issue to the amount of $10,000,000 per annum to be added to the reclamation fund, the bonds to be redeemed from the income returned on the completion of the projects. This plan of increasing the reclamation fund received approval from President Taft in his Conservation speech at Spokane, printed elsewhere in this issue.

MOTOR CARS FOR 11,000-VOLT SERVICE.—At the East Pittsburg shops of the Westinghouse Electric & Manufacturing Co. there is now being installed the electrical equipment of a number of motor cars for the suburban service of the New York, New Haven & Hartford R. R. These cars are designed to operate on the 11,000-volt alternating-current catenary trolley of the main New Haven electrification and on the 600-volt direct-current third-rail section of the New York Central terminal in New York City. As the New Haven equipments are required to operate on a direct-current third-rail, the control equipment for effecting a change from the alternating-current overhead line is necessarily more extensive than had the control been arranged for straight alternating-current operation throughout, but all this auxiliary apparatus has been distributed under the floor, where ample room was found for everything in the space between the trucks. The cars, which are intended to pull trailers, are equipped with four series-compensated motors. These and the step-down auto transformers are supplied with forced ventilation from a blower system. When the equipment is operated under forced ventilation the one-hour rating of each motor is 200 HP. Each car is guaranteed to haul two 50-ton trailers and when so operating will accelerate normally at a rate of 0.7 miles per hour, per second.

The arrangement of the motors differs from that of any other cars in use in this country, in having the motor geared to a quill surrounding the axle, which is geared to the driving wheels by means of springs of the same type as are used on the New Haven locomotives.

The cars are 70 ft. long, weigh 86 tons and have a seating capacity for 72 persons. The cars and trucks were built by the Standard Steel Car Co. and are of fireproof, steel construction throughout. They are handsomely finished and are claimed to be the most easy-riding motor cars ever built.

THE SOUTHERN CALIFORNIA EDISON CO. on Sept. 1 put back into service its Kern River hydro-electric plant No. 1, which had been idle for six months during reconstruction under direction of Mr. W. A. Brackenridge, M. Am. Soc. C. E., of Niagara Falls, N. Y. It was decided to line the old steel main with a new and heavier one and to fill the annular space between the old and new mains with concrete. The new main has a factor of safety of 3. It is made up in 6-ft. sections, and as the circumferential seams could not be riveted in place they were made with tap bolts. As reconstructed the main consists of the central steel pipe, 1 in. thick and 6 ft. diameter, a shell of concrete 6 ins. thick, the old steel shell, ½ in. thick, a ring of concrete 12 ins. to 18 ins. thick, and around this the natural rock of the hillside.

PROGRESS ON THE GATUN LOCKS.—Between Aug. 24, when the work of laying concrete in Gatun Locks with the permanent plant was begun, and the close of work on Sept. 18, 7,066 cu. yds. of concrete had been laid. The amount placed is increasing with the increase in the efficiency of the handling and mixing plants. The best record up to Sept. 18 was made on that day, when 638 cu. yds. were laid. Concrete is being laid at present in the 20-ft. floor of the forebay, in the center of the upper lock chamber, and in the floor of the east chamber of the upper lock. Of the lateral culverts, with the floor wells, 160 ft. have been built, and the forms have been pulled without difficulty.

All three units in the power-house are in working condition. The changes in the automatic electric cars, which carry materials to the mixer, are continuing. Although the chief change made is merely to reinforce the I-beam on which the motors are mounted, in order to do away with the wobbling of the motors, it involves taking the car apart and the work therefore will probably take two weeks or more. The dozen cars that have already been changed are giving satisfactory service. In the cableway plant the electrically controlled air brake by which the speed of hoisting and lowering the buckets is regulated is being changed to hand control.

Wooden forms for the connections between the lateral culverts and the main culverts are being made at the wood shop at Gatun. These forms will be in the shape of an elbow, elliptical at the end which connects with the lateral culverts and circular at the top where the connection with the balance valves of the main tunnels is made. The diameters of the ellipse will be 8 ft. and 6½ ft., respectively, the form will be 25 ft. long, and will weigh between 7,000 and 8,000 lbs. In each pair of locks there will be 25 of these connections between the lateral culverts and the tunnel in the center wall, and 25 between the lateral culverts and the tunnels in the side walls, and 150 forms will therefore be required.—"Canal Record," Sept. 22.

DRY DOCK NO. 4, under construction at the Brooklyn Navy Yard, on which serious trouble has been experienced ever since work started, is again at a standstill, the contract with the Williams Engineering Co. for the construction of the dock having been canceled. The contract for this dock was originally let to George Spearin. His contract was forfeited two years ago and the work was relet to the Williams Engineering Co. Great difficulties were met in the endeavor to cope with the treacherous quicksands which underlie the dock site, so that this contractor also gave up the work. Suits are pending against the Government by both contractors to recover moneys expended upon the work. The official estimate is that only 15% of the work on the dock has been

completed, although it is five years since it was first undertaken. Whether the work will be resumed by the Government by day's labor, or will be abandoned on account of the difficulties in connection with the site, is not now known.

SURPRISE TESTS OF RAILROAD EMPLOYEES have been carried on by the Pennsylvania R. R. during the first six months of this year. In over 156,000 trials practically a perfect record was made, as shown in a recent statement made in behalf of the road. These trials, according to the statement,

are conducted by officials of the railroad, who, at unusual times and places, set signals at caution or danger, extinguish signal lights, display fuses, or place torpedoes on the track, with a view to keeping enginemen constantly on the alert for any and all signals. In conducting surprise tests the officials sometimes extinguish signal lamps, and while enginemen may stop at the signal, failure to report the dark lamp at the next station lays them liable to suspension. Failure to observe any of the rules regarding the operation of trains is disciplined. The average number of tests made each day was 862, and of the total for the six months, 99.6% showed perfect attention. In the 0.4% of failures are included the cases where enginemen passed signals by a few feet before stopping their trains and similar cases, which, though technical violations, were not such as would make an accident possible. The tests made were divided into four classes, in which the following records were made by the men: (1) Block signal rules, 24,292 tests, in which 99.6% of which showed perfect observance on the part of employees; (2) rules governing flagmen, and the use of fuses, torpedoes and other signals, 23,042 tests, of which 99.5% were perfect; (3) trains ahead of schedule time, 53,503 tests with 99.7% perfect; (4) signalmen relieving each other, 99.9% perfect out of 56,112 tests. The line between New York and Philadelphia, the New York division, showed a perfect record in all signal tests, as did the Cresson and the Central divisions. On the Sunbury and Shamokin divisions a total of 8,732 signal rule tests were made and in only 9 cases was the observance imperfect. Of the 26 divisions, 9 reported perfect observance of all block signal rules; 5 were perfect in all other signals; 21 in trains running ahead of schedule time, and 10 in signalmen relieving each other.

MUNICIPAL OWNERSHIP OF WATER-WORKS is to be adopted at Knoxville, Tenn. The U. S. Supreme Court decision in the case of the city against the Knoxville Water Co., rendered last year, appears to have operated to make the company willing to dispose of its plant. The city paid $643,700 cash, assumes bonds to the amount of $639,700, and also assumes liability of $24,000 for any judgments that water consumers may secure in the courts by reason of excess water charges made by the company while litigation involving a schedule of rates made by the city council was on. For the purchase of the plant the city issued bonds amounting to $1,250,000.

AN INFERIOR PUBLIC WATER-SUPPLY is alleged to have caused $300,000 damages to the Oakes Manufacturing Co., of Long Island City, N. Y., during the past six years. Suit was brought by the company against the City of New York (which now includes Long Island City) to recover damages of that amount. The company claimed that the percentage of chlorine in the city's water-supply was so high that the company was unable to manufacture logwood dye extracts at a cost low enough to allow it to compete successfully with other manufacturers. It was also claimed that the steam boilers of the plant were injured by the scale-forming material contained in the water. The suit was brought before Supreme Court Justice Marean, of Brooklyn, and was dismissed by him in response to the petition of the counsel for the city. The Justice held that the Department of Water Supply performed functions of a governmental nature, and for its acts the taxpayers could not be mulcted in damages by a private citizen. If it was true that the administrative officers of the city furnished an impure water-supply, the residents of the city had their remedy by electing other government officials. The Justice ruled that administrative officers are as supreme in their powers as the judiciary, and the acts of the former cannot be reviewed by the latter except when charges of fraud are made against administrative officers.

RAILWAY ACCIDENTS IN OHIO during the month of September caused the death of 82 persons, 71 of whom were killed on the steam railways and 11 by the electric. None of those killed on the steam lines were passengers, but on the electric roads four passengers were killed. Six persons were killed during the month on grade crossings.

A COMBINATION POWER SHOVEL AND LOCOMOTIVE crane, operated by electricity, has been built for the Winona Interurban Ry. by the Vulcan Steam Shovel Co., and will be used for grading, excavating gravel ballast and hauling material in the railway yards at Warsaw, Ind. The cast steel underframe is mounted on four wheels and fitted with a turntable on which revolves the frame carrying the machinery and the steel boom, which is 36 ft. long. The boom carries a steel dipper handle with 1-yd. bucket, but this may be removed, and the boom used as a crane or to handle a 1½-yd. grab bucket. The machine is self-propelling, with a speed of 300 to 500 ft. per min. on level track. As a crane, it can lift a load of 8 tons at 22 ft. radius, or 7,500 lbs. at 38 ft. radius. As a shovel it can excavate 400 to 600 cu. yds. of ordinary material per day. A 75-HP. motor operates the hoist and the boom topping-lift; a 30-HP. motor operates the swinging and propelling mechanisms. They are operated by 550-volt direct current. A somewhat similar machine, but equipped with steam boiler and engines was illustrated in our issue of Sept. 3, 1908.

Personals.

Mr. H. Sheaver, Secretary to the General Superintendent of the Michigan Central R. R., has been appointed Division Superintendent at St. Thomas, Ont.

Mr. John A. Knox has been appointed Engineer of the Louisiana & Northwest R. R., with office at Homer, La., to succeed Mr. W. A. Hunicke, Assoc. M. Am. Soc. C. E.

Mr. Ralph Budd has resigned his position as Chief Engineer of the Panama R. R., taking effect on Sept. 21. Mr. Frederick Mears has been placed in temporary charge of the engineering department.

Mr. Francis W. Collins, M. Am. Inst. M. E., has become associated with the Construction Service Co., 15 William St., New York City, with whom he will be in charge of railway and public utility valuations.

Mr. B. Latrobe Weston, Assistant Division Engineer for the sewerage commission of Baltimore, Md., has resigned that position to become Assistant Engineer with the Fidelity and Deposit Co. of Baltimore.

Mr. T. Commerford Martin, Past-President Am. Inst. E. E., has resigned the editorship of the "Electrical World," which he has held for more than a score of years, to become Executive Secretary of the National Electric Light Association.

Mr. C. E. Chambers, General Master Mechanic of the Central R. R. of New Jersey, has been appointed Acting Superintendent of Motive Power to take the place of the Superintendent, Mr. William McIntosh, who is absent on leave on account of serious illness.

Mr. W. D. Taylor, M. Am. Soc. C. E., Chief Engineer, and Mr. P. Maher, Superintendent of Motive Power & Equipment, of the Chicago & Alton Ry., have had their jurisdiction extended to include the Minneapolis & St. Louis R. R. and the Iowa Central Ry.

Mr. E. J. Nichols, M. Am. Soc. C. E., who recently resigned his position as Division Engineer of the Galveston, Harrisburg & San Antonio Ry., at Victoria, Tex., has become Superintendent of general construction for the firm of Horton & Horton, railway contractors, at Houston, Tex.

Mr. William A. Brackenridge, M. Am. Soc. C. E., is to resign his position as a member of the Advisory Board of Consulting Engineers for the Improvement of the New York State Canals. He has been made Vice-President and General Manager of the Southern California Edison Co., with headquarters in Los Angeles. Mr. Brackenridge leaves Niagara Falls for his new position on Friday, Oct. 8.

Mr. Horace W. Clarke, recently Assistant General Manager of the International & Great Northern R. R., has been appointed General Manager of the Denver & Rio Grande R. R. Mr. Howard Martin, Division Superintendent of the International & Great Northern at Mart, Tex., has been made Superintendent, with headquarters at Palestine, Tex., and will assume the duties formerly performed by Mr. Clarke. Mr. A. G. Whittington, formerly Trainmaster, succeeds Mr. Martin as Superintendent of the Ft. Worth division.

Mr. C. B. Humphrey, Assoc, Am. Inst. E. E., has resigned his position as Sales Manager of the Westinghouse Electric & Mfg. Co., to become a vice-president and director of the White Investing Co., 43 Exchange Place, New York City. Mr. Humphrey has been with the Westinghouse company for 15 years. Before advancing to the position of Manager of the detail and supply sales department, which he has held for the past five years, he was District Manager at Cincinnati, Ohio.

Obituary.

Lewis C. Grover, M. Am. Soc. M. E., President of the Colt's Patent Firearms Manufacturing Co., died Sept. 30 at Hartford, Conn., at the age of 60 years.

William E. Marsh, who was employed for 35 years in the engineering department of the Southern Pacific Ry., died Sept. 30 at his home in San Francisco, Cal., aged 54 years. His death followed an operation for appendicitis. Mr. Marsh was in charge of work in connection with the construction of the Lucin cut-off across Great Salt Lake in 1902-3.

William Parker, M. Am. Soc. C. E., Principal Assistant Engineer of the Boston & Albany R. R., died Sept. 30 at the Homeopathic Hospital, Boston, Mass., from typhoid fever. Mr. Parker was born at East Bridgewater, Mass., in 1861 and was a graduate of the Bridgewater high school. He entered the service of the Boston & Albany R. R. in 1885 as a surveyor and subsequently became Assistant Roadmaster, Division Engineer and Principal Assistant Engineer.

John O'Neil, for several years Superintendent of Track Elevation at Chicago, died on Oct. 26, at the age of 74. As an alderman, he was largely instrumental in persuading the city authorities to adopt (in 1892) the policy of track elevation and (under the city's police regulation) to require the railways to do this work at their own expense. As a result of his activity in this matter he was appointed Superintendent of Track Elevation, and held this position until a few years ago, when he resigned.

David H. Cochran, formerly President of the Brooklyn Polytechnic Institute, died Oct. 4 at his home in Brooklyn, N. Y. Dr. Cochran was born at Springville, N. Y., in 1828 and was a graduate of Hamilton College in the class of 1850. After graduating he became successively Professor of natural sciences at the Clinton Liberal Institute, Fort Plain, N. Y.; Principal of Fredonia Academy, Chautauqua Co., N. Y.; Professor of physics and chemistry and subsequently President of the State Normal School, Albany, N. Y. In 1864 he became President of the Brooklyn Polytechnic Institute and held this position up to the time of his resignation in May, 1890.

Engineering Societies.

COMING MEETINGS.

RAILWAY SIGNAL ASSOCIATION.
Oct. 12-14. Annual convention at Louisville, Ky. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 19. Annual convention at Jacksonville, Fla. Secy., S. F. Patterson, Boston & Maine R. R., Concord, N. H.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 19-22. Annual convention at Richmond, Va. Secy., Chas. O. Probst, Columbus, Ohio.

AMERICAN GAS INSTITUTE.
Oct. 20. Annual meeting at Detroit, Mich. Secy., A. B. Beadle, 29 W. 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Oct. 29-30. Annual meeting at New York City. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Nov. 9-11. Annual convention at Little Rock, Ark. Secy., A. P. Folwell, 239 West 39th St., New York City.

NATIONAL MUNICIPAL LEAGUE.
Nov. 15-19. Annual meeting at Cincinnati, Ohio. Secy., Clinton R. Woodruff, Philadelphia, Pa.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 16. Annual meeting at Washington, D. C. Secy., Martin S. Decker, Albany, N. Y.

AMERICAN RAILWAY ASSOCIATION.
Nov. 17. Annual meeting at Chicago, Ill. Secy., W. F. Allen, 24 Park Place, N. Y.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 18-19. Annual meeting at New York City. Secy., W. J. Baxter, 29 West 39th St., New York City.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 1-3. Annual convention at Milwaukee, Wis. Secy., James C. Monaghan, 20 West 44th St., New York City.

NEW JERSEY SANITARY ASSOCIATION.
Dec. 3-4. Annual meeting at Laurel-in-the-Pines, Lakewood, N. J. Secy., J. A. Exton, 75 Beech St., Arlington, N. J.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 6. Annual meeting in New York City. Secy., Wm. H. Ross, 154 Nassau St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 7-10. Annual meeting at New York City. Secy., C. W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 8-10. Annual meeting at Philadelphia, Pa. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 14-15. Annual meeting at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Pa.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 14-16. Annual convention at Washington, D. C. Secy., Glenn Brown, The Octagon, Washington, D. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—An innovation is to be introduced this month in the shape of regular meetings at Boston and at St. Louis. The meeting at St. Louis Oct. 16 will be held jointly with the Engineers' Club of St. Louis, and Professor R. C. Carpenter will present again at this meeting the paper on the high-pressure fire-service system of New York City which is to be presented at the New York meeting of Oct. 12.

The Boston meeting will be held Oct. 20 jointly with the Boston Society of Civil Engineers. A paper will be presented by Mr. Gaetano Lanza and Mr. Lawrence S. Smith on "Comparison of Results Obtained by the Use of Three Theories of the Distribution of Stresses in Reinforced-Concrete Beams." This paper gives the results of extended experiments upon full-sized beams.

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